9.95 08/13M
ILICON CHIP
11 15
NEW
Top
201001044191
260613 3

ILICON CHIP

JULY 2013
ISSN 1030-2662
07
9 771030 266001
PRINT POST APPROVED
- PP255003/01272
$9.95* INC GST NZ$12.90 INC GST

ALL NEW!

Li'l Pulser

✔ Great Control
✔ With Braking
✔ With Inertia

Model Train Controller

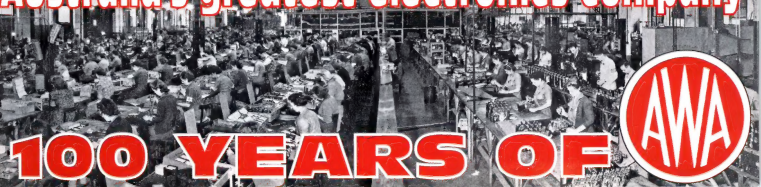
LONG-RANGE REMOTE CONTROL:

Convert your remote to BOTH Infrared AND UHF!

Wireless Audio Streaming

DIY music anywhere you want it . . . WITHOUT RUNNING WIRES!

Australia's greatest electronics company



100 YEARS OF AWA

Jaycar Electronics
Better, More Technical

WINTER PROJECTS

Prices valid to 23/07/2011

JULY EDITION

Test & Inspection Equipment

12VDC Voltage Polarity Easy Tester

A passive, quick and easy testing solution that performs five essential tests in the field: voltage, load, polarity, voltage drop and continuity. Ideal for CCTV and security installers, car audio, roadies, AV techs etc.

- Size: 51(L) x 44(W) x 29(H)mm

QP-2215 *was $24.95*

$14.95 SAVE $10

USB Mini Inspection Camera

Use a laptop as a monitor to check for termites and other rodents, insulation, finding lost tools etc. Features a 10mm diameter camera with two variable intensity LEDs for illumination.

- 7m long cable
- Mirror and magnet pick-up tool included
- Software included
- Size: 10(Dia.) x 7(L)mm

QC-3371 *was $59.95*

$44.95 SAVE $15

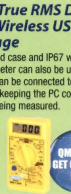
IP67 True RMS DMM with Wireless USB & Storage

Double moulded case and IP67 waterproof protected. This meter can also be used as a data logger which can be connected to a PC via wireless USB interface keeping the PC completely isolated from whatever is being measured.

- True RMS
- Data hold, auto ranging
- 10A max AC or DC
- 1000V max AC or DC
- Size: 182(H) x 82(W) x 55(D)mm

QM-1575

QM-1500 worth $9.95



BUY QM-1575 & GET QM-1500 FREE

$179.00

Tool Set Repair Kit for iPhone®

The tools you need to safely open up your iPhone® and put it back together again. Suits iPhone® 3G, 3GS & 4G. See website for list of contents.

TD-2112 *was $12.95*

$9.95 SAVE $3

iPhone® not included

PRECISION Tool Kit

This handy set will fit the bill for all those microscopic fasteners we come across in modern electronics. Along side these 15 piece drivers (TD-2069 $24.95) are five stainless steel 115mm cutters and pliers (TH-1812 $29.95) and a sturdy ABS storage case (HB-6304 $8.95) with solid clasps and removable compartment trays.

$49.95

Total Package valued at $83.85 save $13.90

Economy Non-Contact Thermometer

Safely measure temperature in hot, hazardous, or hard to reach places with the built-in laser pointer directed at the surface. Provides several readings within seconds. Compact and easy to use with carry case included.

- 8:1 Distance to spot ratio
- Auto data hold
- Temperature range: -30°C to +260°C
- Size: 131(H) x 96(W) x 35(D)mm

QM-7215

$49.95

Filter Your TV Reception!

A large part of the TV spectrum is being reallocated to mobile phone services (for LTE Technology). This means that future mobile phone services may interfere with your TV reception. You can eliminate this problem by inserting this filter into the antenna input line of your TV. No power supply required.

- F type connectors
- Freq. Range: 5-694MHz
- Size: 47(L) x 21(Dia.)mm

LT-3061

NEW **$24.95**

High-Power Class-D Audio Amplifier Kit

Refer: Silicon Chip Magazine Nov/Dec 2012

High quality amplifier boasting 250WRMS output into 4 ohms, 150W into 8 ohms and can be bridged with a second kit for 450W into 8 ohms. Features include high efficiency (90% @ 4 ohm), low distortion and noise (<0.01%), and over-current, over-temperature, under-voltage, over-voltage and DC offset protection. Kit supplied with double sided, soldermasked and screen-printed silk-screened PCB with SMD IC pre-soldered, heatsink, and electronic circuit board mounted components.

- Power requirements: -57V/0/+57V (see KC-5517)
- S/N ratio: 103dB
- Freq. response: 10Hz - 10kHz, +/- 1dB
- PCB: 117 x 167mm

KC-5514

Also available:

Stereo Speaker Protector Kit to suit

KC-5515 $29.95

+/- 57V Power Supply Kit to suit

KC-5517 $29.95

$89.95

PCB Etching Kit

An ideal kit for anyone to etch a circuit board. Complete with an assortment of copper boards, etchant, working bath and tweezers. It also includes photosensitive PCB and developer. See web site for full list of inclusions.

HG-9990 *was $27.95*

$19.95 SAVE $8

ATTENTION KIT BUILDERS

Can't find the kit you are looking for? Try the Jaycar Kit Back Catalogue

Our central warehouse keeps a quantity of older and slow-moving kits that can no longer be held in stores. A list of kits can be found on page 79 of our catalogue or our website. Just search for "kit back catalogue".

Contents

SILICON CHIP

Vol.26, No.7; July 2013 www.siliconchip.com.au

100 Years Of AWA – Page 12.

Features

12 100 Years Of AWA
It's now 100 years since the formation of Amalgamated Wireless Australasia Ltd (AWA), the most important electronics company ever to exist in Australia – by Kevin Poulter

20 Cheap & Cheerful Smart TV Conversion
Why buy a smart TV when you can do a simple work-around with your existing TV? You could end up with a smarter TV than a smart TV! – by Julian James

44 Secure Digital Cards: Clearing Up the Confusion
There are many different kinds of SD & MicroSD cards. We take a look at their differences and at the technology behind them – by Nicholas Vinen

Projects To Build

24 DIY Wireless Audio Streaming
Want to wirelessly stream high-quality audio from your PC to a USB audio device such as our CLASSiC DAC? Here's how to hack a cheap router to do the job – by Nicholas Vinen

32 Li'l Pulser Model Train Controller, Mk.2
New design features pulse power for smooth running, adjustable simulated inertia, good speed regulation, reversing, short circuit protection and an output current capability of up to 8A. It's also very easy to build – by John Clarke

64 Add A UHF Link To A Universal Remote Control
Need longer range from your IR remote control? Fit this tiny IR-To-UHF module inside the remote and build the companion UHF-To-IR receiver to operate equipment from anywhere inside or outside your home – by John Clarke

74 Demonstration Circuits For Human Colour Vision
Build these two circuits to demonstrate how the various colours are generated and perceived by the human eye – by James Goding

84 Build A USB Port Voltage Checker
An incorrectly wired USB port can destroy a flash drive. Test it first with this handy USB port checker. It can also be used to check for USB voltage fluctuations when a device is plugged in – by Nicholas Vinen

DIY Wireless Audio Streaming – Page 24.

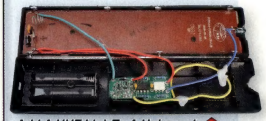
Li'l Pulser Model Train Controller Mk.2 – Page 32.

Special Columns

57 Serviceman's Log
Smoke: it's not always a bad thing – by Dave Thompson

76 Circuit Notebook
(1) Trailer Light Testing Unit; (2) Audio Breakout Cable For The iPhone; (3) Setting A Real Time Clock With GPS Time

90 Vintage Radio
Restoring an AWA B15 AM broadcast receiver – by Rodney Champness



Add A UHF Link To A Universal Remote Control – Page 64.

Departments

2 Publisher's Letter
3 Mailbag
73 Subscriptions
88 Product Showcase
96 Online Shop
98 Ask Silicon Chip
103 Market Centre

Build This USB Port Voltage Checker – Page 84.

SILICON CHIP
www.siliconchip.com.au

Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc. (Hons.)

Technical Editor
John Clarke, B.E.(Elec.)

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc
Nicholas Vinen

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Kevin Poulter
Stan Swan
Dave Thompson

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490. All material is copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $105.00 per year in Australia. For overseas rates, see our website or the subscriptions page in this issue.

Editorial office:
Unit 1, 234 Harbord Rd,
Brookvale, NSW 2100.

Postal address: PO Box 139,
Collaroy Beach, NSW 2097.

Phone (02) 9939 3295.

Fax (02) 9939 2648.

E-mail: silicon@siliconchip.com.au

ISSN 1030-2662
Recommended and maximum price only.

Publisher's Letter

Nuclear power is the answer

Back in February 2013 we published a feature article by Dr David Maddison on the historic Rubicon hydroelectric power station in Victoria which is actually still running today after being completed in 1929. At the end of that article, the author commented about the comparable costs of hydroelectric versus nuclear power. It was a logical comment but it triggered a letter to the Mailbag pages in the April 2013 issue from one reader who decried the thousands of deaths and environmental damage due to the nuclear power stations and associated disasters.

In fact, I added a comment to that letter which contradicted some of what he said but that was not enough to mollify informed readers who vehemently disagreed with the letter's content. We have featured three of their letters in the Mailbag pages of this issue and they all emphasise the exceptional safety record of nuclear power stations, notwithstanding the events at Chernobyl, Three Mile Island and Fukushima.

Fukushima has obviously triggered some wildly illogical decisions in Europe, the most notable being the decision by the German government to decommission all of its nuclear power stations. They need to make up the shortfall in electricity generation by burning more coal and natural gas. Not only is this increasing electricity costs to German consumers but it means that there is more air pollution and greatly increased output of that dreaded carbon dioxide which supposedly leads to inexorable global warming. Well, only those people who have been hunkered down in a cave (presumably unheated) would not realise that the nexus between rising carbon dioxide and global warming has been seriously challenged.

But if decisions to close nuclear power stations are illogical, what is happening to the huge Drax coal-fired power station in England utterly beggars belief. Due to the need for the UK to comply with EU directives about "carbon pollution", it has become uneconomic for the Drax power station to burn coal. They use 36,000 tonnes of it every day. Big problem. But they can burn biomass. It is much more expensive but they can get government subsidies because burning biomass supposedly comes under the heading of "renewable energy". Never mind the fact that taxpayers have to pay for this.

So what sort of biomass will Drax be burning? Wood! Yes, they are going to import millions of tonnes of wood from the USA! Utterly bizarre!

All of which makes Australian governments' various measures to combat global warming seem almost sane by comparison. Except that they are not sane or sensible. It is doubtful whether all the measures put in place, including the substantial subsidies to solar and wind power, have had any significant effect on Australia's overall emissions of carbon dioxide. Sure, overall electricity consumption has dropped a little but that is probably more a result of consumers reducing electricity usage in response to rising prices than any other factor.

We now have the situation in Australia where virtually all our existing coal-fired power stations are getting to the point where they need to be replaced or upgraded. But there does not appear to be any plan for this from the various state governments. Nor is there any incentive for private enterprise to build or upgrade new coal-fired power stations. Soon, that will have to change.

Hopefully, with the election of a new government in a few months' time, there will be a change so that serious planning can be done for new power generation. And given the known environmental drawbacks of coal-mining and coal-fired power stations, that planning must include nuclear power stations to provide base-load power. No-one should be under the illusion that Australia's base-load electricity can be provided by solar and wind power. Let the debate begin.

Leo Simpson

MAILBAG

Letters and emails should contain complete name, address and daytime phone number. Letters to the Editor are submitted on the condition that Silicon Chip Publications Pty Ltd may edit and has the right to reproduce in electronic form and communicate these letters. This also applies to submissions to "Ask SILICON CHIP" and "Circuit Notebook".

Good article on lithium batteries

I would like to offer my congratulations to Stan Swan. His article on $LiFePO_4$ batteries in the June 2013 issue was very informative and a pleasure to read. It is obvious that these batteries and their close cousins, the Lithium Polymer types, will be the portable power supply of choice in the not too distant future.

Well done Stan and thanks for a very useful article.

Jeff Monegal,
Jimboomba, Qld.

Modular functions are the way to go

I wish to comment on the Publisher's Letter in the May 2013 issue, on the amount of the complexity that should be put into individual projects, particularly those that are software-driven. I use my current practical interests as two different examples.

At the moment, I am updating my ageing although still well-performing audio system. Even today, the bedrock and major cost of a good-quality audio system is the speakers and power amplifiers.

Small signal systems now abound since digital recording and transmission blossomed with the use of cheap computers and LSI chips. So bringing all inputs altogether in a versatile audio/video distribution system tailored for one's own requirements is now the ideal. It is one which is very expensive for top-quality off-the-shelf consumer products and an area of the market where SILICON CHIP is highly competitive and could be an innovative leader.

The new CLASSiC DAC has six digital inputs which would form the basis of a high-quality preamp. Coupled with the modules from the stereo preamplifier in November & December 2011 and a subwoofer module makes a 2.1 system with a remote volume control. I need only one RCA input for the FM radio; the rest are now digital while many are also fed via HDMI through the TV to the audio system.

The power amplifiers can have simple volume controls which especially for a home-theatre system can all be preset and sealed for balance. The system being modular and able to be updated, other people with different needs can adapt the modules to their purposes.

I would like to update to home-theatre but I wonder if it is possible to remove a decoder chip from an old DVD player and use a piggyback board to insert it into a DAC system?

Secondly, for science-based projects and similar where appearance is not the issue, experimenters can put modules to other uses, especially if only software is needed to change function. The new Raspberry Pi springs to mind and perhaps could be made into a field module.

Initially, it could be a useful addition to the Infrasound Detector from the March 2013 issue as a frequency multiplier, to bring the LF output into the audio range. The brain is much better adapted to processing audio than trying to understand visual representation. It would make the infrasound detector a quick and very rapid scanning/recording instrument.

SILICON CHIP is as much, if not more, a current technology and educational informational magazine as a home project construction publication. It covers a wide level of readership including and most importantly the school-age family group.

SILICON CHIP's many articles explaining technology are always carefully written to satisfy a wide-ranging level of readership. The classic must be the series of Engine Management articles which surely must now be the standard learning text for the auto industry; brilliant.

Kelvin Jones,
Kingston, Tas.

Solar installation that re-fused to power up

While doing a walk around my home, I noticed the inverter on my

USB dongle & software-defined radio

I have two comments about the article in May 2013 regarding these devices. Your very last paragraph mentions a spurious peak on the display. This is generally caused by a slight imbalance between the "I" and "Q" signals. Luckily, SDR# can overcome this automatically.

In the top lefthand control area of the "Radio" box, there is a tick box marked "Correct IQ". Ticking this will eliminate the spurious peak and as an added bonus, the very top line of the window will now show the extent of the correction. In my case, an amplitude error of about 1.005 and a phase error of about 0.05°; not very much but enough.

The other point is a matter of convenience more than anything else. In each of your screen grabs, you show a large amount of "dead" space in the spectrum displays, ie, the blue area in the lower half of the display. Since these dongles only use 8-bit data, their dynamic range is not great and will never use the lower half of the display.

Once again the software comes to the rescue. In the "FFT Display" box, the lowest slider sets the range of this display and a quick adjustment will bring the lower edge of the display to say -70dB and eliminate most of the waste space.

Ian Malcolm,
Scoresby, Vic.

Mailbag: continued

Extra circuit features are always welcome

Regarding your May 2013 Publisher's Letter requesting feedback on DAC-type projects, I'm sure that constructors of the kit would automatically welcome the extra features. But what proportion of readership would benefit from said action, as opposed to the number that construct the Do-Not-Disturb Telephone Timer?

With the advent of microcontroller-based projects, we get away from basic electronic principles, eg, how transistors are biased and utilised. For newcomers, descriptions detailing component use are normally only reserved for how power supplies work (eg, the CLASSiC-D's DC-DC converter) and even then, a complex IC (TL494) is used.

What I'm alluding to is the untapped market of electronic enthusiasts with basic electronic knowledge, that play with Arduino and Ti LaunchPad microcontrollers etc. I do not mean we need more projects based on these devices but feel that at every opportunity (if you use a device like the PIC12F675) you should put the commented source code up on your website.

Even if one is not going to construct the project, the readers can gain knowledge in how the code is utilised. Most people know C these days and of course BASIC from the PICAXE. It would be nice to see how a simple (on the surface) circuit with a PIC, two transistors, nine diodes and a few passive components can perform as a phone timer function.

I have purchased every magazine since the "Radio Television and Hobbies" days and still look forward to each issue but in most cases, it's now the Circuit Notebook I turn to first.

Grant Forest,
Whittington, Vic.

solar power system was not working despite it being a clear sunny day. A quick check with the voltmeter showed that there was 300V DC at the inverter input and the grid-feed AC reference was present. However, when the DC was reconnected to the inverter, the voltage dropped to zero.

Thinking the over-voltage protection had tripped, I then checked the protection MOVs and associated PTCs (as these are designed for easy replacement). Unfortunately, they were OK and were not the problem. A check of the purchase documents showed that the warranty for the inverter had expired three months ago.

Faced with the prospect of buying a new inverter or, as I was informed by the manufacturer, buying an exchange unit for 450 euro (whatever that is in Australian dollars), I still had a niggling thought that the problem may be external to the inverter. It appeared that the solar panels couldn't supply the necessary current (around 4A) so after a quick risk assessment, I clambered onto the roof and started inspecting the solar panels (as they come with a 25-year warranty).

My first observation was a junction box that contained an in-line fuse. I could measure 300V DC on both ends of the fuse, which at first made me believe it was OK (this measurement was taken with the inverter disconnected – hence no load current). I then checked the resistance of the fuse out of circuit. It measured around 2kΩ and shaking it changed its resistance. The fuse hadn't blown but had just grown old and tired.

Under load conditions, the full voltage was dissipated across the fuse. When not drawing current there was no voltage drop, which was why I could measure 300V at the inverter input but it fell to zero when I put the inverter load onto it. Replacing the fuse restored the system to full functionality, much to my relief.

Now here is my dilemma: why is the fuse there? It is on the roof in an enclosed box and used as a connection point between the solar panels and the cable feeding down to the inverter (via circuit breakers). The fuse is rated at 8A and it is a DC fuse, to provide arc suppression, however the maximum current the panels can supply (it is a 1kW system) under short circuit conditions is 4A (one commissioning tests is to measure the short circuit current) hence under worst-case fault conditions the fuse can never blow.

Will the replacement fuse deteriorate over time, given that it is in a sealed box on a metal roof in full northern sun (hence lots of heat)? Assuming the fuse failure was due to environmental factors, then gradual deterioration of the fuse over time will also reduce the efficiency of the system (hence increased power bills), until again in five years time it will get to a point where the system shuts down again – and I am too old to climb back onto the roof!

Rob Howes,
Ellenbrook, WA.

Simple phones still available

Your correspondents John Anwin and Cliff King (Mailbag, May 2013) complain that their smartphones have too many options and sometimes get activated while being pulled out of their pockets. They want a phone that only sends and receives calls and text messages. The compact fold-over Samsung GT-E1150i does exactly what they want and costs just $39.

James Goding,
Carlton North, Vic.

Science of global warming endorsed

In the Mailbag column of the May 2013 issue, you added a comment following the letter by Peter Carter entitled "Do wind farms really make people sick?" You questioned the science of global warming. I beg to differ. You don't need a degree in science to see why human activity is driving global warming and climate change.

Consider how the fossil fuels were originally created. Many millions of years ago, there were many more volcanoes than there are now. These released huge quantities of carbon dioxide (CO_2) into the atmosphere. The huge quantities of CO_2 made the planet several degrees warmer than today and consequently, there was no ice at the poles and much of the land was covered by lush forest. There was also massive growth of algae type plants in warm, shallow seas.

These plants took in the CO_2 and, by photosynthesis, stored the carbon

and released oxygen into the air. As the vegetation died, it fell to the forest floor and as the algae died, they sank to the bottom, thus creating thick layers of organic material on the forest floor and at the bottom of the shallow seas.

In time, the marine debris became oil and gas. If you go to the open cut brown coal mines in Victoria, you can actually see the fossils of trees and ferns etc in the coal.

The planet then went into a cooling trend because of the carbon stored in the plants and underground in the coal, oil and gas. Ice again formed at the poles and the planet resumed its natural cycle of warming and cooling until humans intervened. Since about 1850, the world population has been rising rapidly and we have been cutting down forests thus reducing the level of photosynthesis and removing the fossil fuels from the ground and largely burning them hence releasing the stored carbon back into the atmosphere as CO_2.

We are therefore returning the planet to the situation that existed when the fossil fuels were created originally. There have always been, and always will be, ripples in the graph of the average global temperature. However, the pertinent issue is the long term trend, not short term variations.

Len Cox,
Forest Hill, Vic.

Comment: once again, the "science" is not nearly as simple or as "settled" as many believe. It is true that volcanoes originally released vast quantities of CO_2 which was then stored underground as coal, oil and gas which humans have heavily exploited since the industrial revolution. But even if we manage to burn all those resources, the atmosphere will never again contain as much CO_2 because a huge proportion of it is now locked up in limestone and other calcium carbonate rock.

Second, just recently there has been a paper published by Professor Qing-Bin Lu in the International Journal of Modern Physics B. The paper is at odds with the belief that climate change is driven by increasing concentrations of CO_2 in the atmosphere. Instead, it links global warming and the subsequent cooling of the atmosphere in the last decade or so to the rise and fall of CFCs (chlorofluorocarbons). It is thought that declining CFCs will lead to further atmospheric cooling for the next 50 to 70 years while the carbon dioxide level continues to climb.

In the meantime, it seems that solar activity has much more effect on the atmosphere than previously recognised, with the current very low solar cycle possibly leading to protracted cooling. No-one really knows what is going on.

Finally, it is by no means certain that there are now less volcanoes than in prehistoric times. There are vast numbers of undersea volcanoes, many of them active. They are still forming new islands today.

For the wind turbine infrasound sceptics

I hope that this letter goes some way toward giving those who claim that industrial wind turbines have no effect on human health, pause for thought. I am a retired Naval Electrical

ONLINE & IN STOCK

MEANWELL DC-DC CONVERTERS

> 0.5W to 300W supplies
> Module, Half-Brick, On-Board, PCB and Enclosed Type models available
> 2 to 3 years warranty

MEANWELL AC-DC OPEN FRAME SWITCHING POWER SUPPLY

> 5W to 300W supplies
> Single, Dual, Triple and Quad supply models available
> Encapsulated and On-Board models available

ONLINE & IN STOCK

PLACE AN ORDER:
FREE CALL **1800 MEANWELL** (1800 632 693)
WWW.POWER-SUPPLIES-AUSTRALIA.COM.AU
VISA AND MASTERCARD ACCEPTED

PowerSupplies Australia
YOUR ONE STOP MEANWELL ONLINE POWER SUPPLY SHOP
MEAN WELL

Mailbag: continued

Patch leads are critical in ADSL

I certainly sympathise with Kimble Dunster (Mailbag, June 2013, pages 11-12). Such shenanigans with some phone technicians (and contractors too) are infuriating, though thankfully in a minority, although that's no comfort to the victim! Also, overseas call centres, which Telstra has regrettably decided to use, give distinctly variable levels of "service" and Telstra's supplier seems to have more than its fair share of people who know nothing about technology.

However, I would like to clarify a misunderstanding in Kimble's letter, although it turned out not to be the reason for his problem, which he correctly divined. He wonders "how one metre of cable inside would make any difference to the 3km of 30-year old wet copper with lots of joins between the wall socket and the exchange".

The reason why the length of the patch lead is generally critical is that such leads are a flat pair with no twists (undoubtedly for reasons of economy of manufacture) and are thus very vulnerable to AC and RF interference, which can certainly create problems with the RF of ADSL.

On the other hand, the "3km of wet copper" will be in multiconductor twisted pair cable, where the twists in each pair have the effect of cancelling noise in individual conductors. This was explained in my article "Getting the Most from ADSL" in the May 2012 issue.

Incidentally, there is no problem with "wet copper" (or its age) per se. The problem is certainly with wet joints, if they have previously been poorly made, which again is regrettably often the case. We can tolerate considerable noise in the analog environment of POTS but this can become highly troublesome when we use the freak technology of ADSL.

Alan Ford,
Salamander Bay, NSW.

Engineering Officer (RAN) who took up beef cattle farming 24 years ago.

In 1997, my wife and, I along with all our neighbours, signed up to host wind turbines on our farms, both for the added income and to "do our bit" to help the ecology by producing "clean" energy. We were told that we would not even hear the turbines above the background noise levels.

After the turbines were installed, that quickly proved to be wrong. In 2004, the wind "farm" was operational with two 1.75MW turbines installed on our property as part of a much larger wind "farm". Those turbines were 750 metres from the farmhouse, giving a total of 10 turbines within a 2.5km radius of our home, with many more stretching away at roughly 400-metre intervals. We found that the audible blade noise was annoying, particularly when coupled with large diesel centre-pivot irrigation plants next door running day and night.

We owned a four-hectare (10-acre) block that we had intended to retire to 5km from the farmhouse and 2.5km from the nearest turbines and so in 2005/6, we built and moved in years earlier than intended. We thought we would be free from the noise as the wind very rarely blows from the direction of the turbines and in addition, we cannot see them from the house due to a small forest of stringy bark gum trees.

Virtually from the moment we moved into the new house in 2006, I began to develop symptoms such as tinnitus, apparent heart arrhythmia, bouts of depression, nocturnal panic attacks, angina-like chest pains and waking in the morning as though I had not slept. My doctor could find nothing wrong and ECG tests showed nothing wrong with my heart. I began to think that we had either built a "sick" house or the ageing process had really set in.

By sheer chance, in March 2012 I heard a farmer from Victoria claim that since he had a wind-farm constructed near his home he had been experiencing adverse health conditions which he believed were caused by the wind turbines. As he listed the symptoms he had been experiencing, I noted that they mirrored mine exactly.

My wife and I decided to get away from the area for a day or two. Interestingly, the pulsing sensation disappeared and we had a wonderful sleep. When we returned home, the symptoms reappeared. We repeated the absence test for as short as overnight to as long as two months and in every case, ALL of the symptoms disappeared only to reappear shortly after being back in our home.

In January this year, we had a highly qualified acoustician carry out a three

NEW

PA4000 — Tektronix Power Analyser

Fully characterize your power electronics designs with confidence

- Good stability over entire current, voltage and temperature range
- Measure from µW to KW
- Full suite of power measurement up to 100th harmonic
- Able to make accurate measurement up to Crest Factor of 10
- Fast auto-ranging enable accurate measurement in changing conditions
- Build in PWM motor mode, lighting ballast mode, standby current and integrator mode
- USB, LAN and RS232C connection standard

TM TekMark

TekMark Australia • www.tekmark.net.au • Call 1300 811 355 or email enquiries@tekmarkgroup.com

Tektronix

week logging of the (unweighted) sound pressure level (SPL) inside our home in the frequency range 1Hz to 3kHz. Interestingly, the 10-minute averaging "screen shot" showed a level of infrasound centred at approximately 4Hz, at between 50-70dB, significantly above the "noise floor". Is it a coincidence that there are four turbines at a distance of 2.5km from our home which rotate at slightly different rates, where one could expect at a blade pass rate of one per second (three blade turbines) a frequency of 4Hz? There are more turbines in the same direction a further 1km distant.

I understand that audible sound attenuates at 6dB per doubling of distance but infrasound only at 3dB per doubling. If so, this would explain why people are being affected when they cannot hear the audible noise of the turbines. It may also explain why people in residences within a few hundred metres of turbines are not affected due to the elevation of the infrasound source, eg on a hill top, whilst the houses are at the base of the hill. The infrasound may well pass over the residence and not at it.

I also do not believe that the infrasound we measured is related to building self-resonance, as the centre of the infrasound plot moved up and down in frequency as the wind speed changed. We have no immediate neighbours and disconnecting our electricity supply had no affect on the noise plot. The income that the wind turbines generate for us is nice but we would much rather have our health back without having to become "wind turbine refugees".

I cannot stress enough the debilitating effects of being continually bombarded with the low-frequency and infrasound energy from the turbines nor the profound "silence" inside my head when I sleep away from the turbines. I truly envy those who do not have to sleep with them.

David Mortimer,
Millicent, SA.

Sony Betamax camera free to a good home

In the early 1980s I bought perhaps one of the very first video cameras, a Sony Beta, in a huge rugged case.

After recording only about 10 tapes, obsolescence/technology overtook it. The Nicad batteries have died but the rest (including power pack and a Sanyo Beta video recorder/player) should be OK.

Rather than give them to the recyclers, are these items "vintage" enough for some deserving museum/enthusiast group? If they are in suburban Sydney, I'm happy to deliver.

Neville Snow, Burwood, NSW.
Phone (02) 9744 0320.

Nuclear radiation danger is low

Alex Danilov wrote about the nuclear option being unsafe (Mailbag, April 2013, page 4). We might ask him how it compares with other electricity generation technologies as to its safety.

That was answered by the 1991 Helsinki Report by many world agencies, produced before the 1992 conference at Rio de Janeiro, but green thinking went for "alternative" technologies such as wind, biomass, solar, tidal and wave, forgetting that oil, gas, coal-seam gas, shale gas, coal and

The Convenient All-in-One Solution
for Custom-Designed Front Panels & Enclosures

You design it
to your specifications using our FREE CAD software, Front Panel Designer

We machine it
and ship to you a professionally finished product, no minimum quantity required

- Cost effective prototypes and production runs with no setup charges
- Powder-coated and anodized finishes in various colors
- Select from aluminum, acrylic or provide your own material
- Standard lead time in 5 days or express manufacturing in 3 or 1 days

FRONT PANEL EXPRESS
FrontPanelExpress.com
1(800)FPE-9060

Quick Thinking Pty Ltd
AUSTRALIAN INVENTIONS

New!

DC power distribution!

QuickThinking.com.au

Mailbag: continued

No compensation for obsolete wireless microphones

The article on Wireless Microphones by Ross Tester in the June 2013 issue of SILICON CHIP was certainly an eye-opener for me, as I had no idea this was happening. Now I'm worried.

I run a small amateur theatre group and over recent years have managed to beg, buy or borrow 10 wireless microphone sets which we use in our productions. Unfortunately, these all operate in the dreaded "Digital Dividend" which means, if I read your article correctly, I will soon have 10 paper weights.

There was nothing mentioned in the article about any compensation for non-profit groups such as ours – we certainly don't have the funds to buy new "legal" wireless microphones. Has the Government made any comment about earmarking some of the money from the Digital Dividend sale to compensating those who have to (by Government decision) replace their equipment?

B. A,
North Ryde, NSW.

Ross Tester replies: Don't hold your breath! When the article was written, the Government had not announced the results of the Digital Dividend auction but has since done so – almost two billion dollars straight into consolidated revenue, with more to come. And while there were several submissions from non-profit groups like yours asking that compensation be considered, the Government has been strangely silent.

A "back of the envelope" calculation suggests that there will be about $25 million worth of wireless microphones scrapped. We agree, it's not too much to ask that about 1% of their windfall auction profit be set aside for compensation for groups such as yours . . . and mine (my surf club has three such wireless mics, one of which was purchased in late 2012, before we became aware of the problem).

nuclear are just as "alternative" as the others.

Danilov says that uranium and the radioactive materials associated with it cause harm. Can he explain why dolphins and marine life manage to survive in an environment which has three tonnes of uranium, plus its radioactive decay products, per cubic kilometre of ocean water which also contains cosmogenic radioisotopes?

Humans live on a land surface which has, on average, about 600 times the radioactivity of the ocean. We know that the world is exposed to environmental radiation from terrestrial and cosmic sources; it's a wonder that some people claim that it is so dangerous. If it was so dangerous, life would not exist. Uranium and its "wastes" have always been part of our environment. My body contains uranium and other radioisotopes from the natural environment.

Civil nuclear electricity has been produced since 1956. Waste from nuclear electricity has been accumulating since then. If the waste is so terrible and incapable of being handled safely, Danilov needs to provide some health data rather than simply stating that there is no safe method of storing it. The nuclear industry is tightly regulated and there is a comprehensive collation of nuclear or radiation incidents and accidents available for many years in documents pre-dating the internet. I know because I handled radioactive materials from 1970 until 1992.

Because of the great fear induced about radioactivity (remember the mutant monster fly and other beast movies, not to mention The China Syndrome, starring Jane Fonda), governments spent big on measuring natural background radioactivity and radiation from nuclear power operation.

The Helsinki Report did so more than 20 years ago. UNSCEAR has provided an excellent summary of radiation from the natural background and a host of industries, none of which is radiation-free. Life has never been

radiation-free and its time that people like Danilov understood that simple fact.

As a radiation worker I had my radiation dose monitored and recorded by law but nobody recorded the radiation doses I received from my extensive air travel or my diagnostic X-rays and CAT scans which have helped me to travel well towards my OBE (over bloody eighty) next year.

My mother was diagnosed with a rare blood cancer and the only therapy which worked was an injection of radioactive phosphorus-32. She had five trips to Australia, nine doses of radiation in 30 years and she died aged 94, after a very rich life.

If Danilov thinks that any dose of radiation is harmful I'd advise him not to live in countries which have higher natural background radiation than Australia. That includes all the countries in the European Union. He should avoid air travel which incurs exposure to cosmic radiation. Medical X-rays and CAT scans give us radiation doses far in excess of what we would get from nuclear electricity generation.

Danilov needs to look at the facts of natural radioactivity and anthropogenic releases into the environment before blanket condemnation of nuclear electricity.

I am a member of The Australian Nuclear Association and a founding member of the Australian Nuclear Forum. The latter was concerned about promoting public information and education – see http://oznucforum.customer.netspace.net.au/

Jim Brough,
Stanwell Park, NSW.

Ignorance about safety of nuclear power

Alex Danilov ("Nuclear option is unsafe") is either channelling anti-nuclear propaganda or is ignorant of the facts about nuclear safety or both.

The accidents at Three Mile Island, Chernobyl and Fukushima are not just "three of the best known" nuclear disasters. They were the only reactor accidents in the 60-year history of commercial nuclear power generation which had the potential to cause public health effects from radiation. Even when these accidents are included in the record, experience has shown that nuclear power is one of the safest industries in which to work. The Chernobyl disaster has been the only accident in a commercial power reactor in which a worker has died from radiation exposure.

At Three Mile Island, no-one – either work force or public – was actually harmed by radiation but there were some casualties in road accidents due to the panic evacuation. There were also significant health effects from air pollution due to the increased operation of coal-fired power stations to replace the lost generation of electricity.

At Chernobyl, 31 workers died – 28 of them due to radiation exposure. About 20 other workers have since died from illnesses that are considered likely to have been caused or aggravated by radiation. The only clearly discernible effect of radiation on public health has been an increase in the incidence of thyroid cancer, mainly amongst children living close to the reactor. The exact number of cases is a matter of controversy but is likely to be several thousand. Thyroid cancer is treatable but is typically 5% fatal.

Thyroid cancer is a largely avoidable consequence of a reactor accident if stable iodine is administered immediately to block the uptake of radioactive iodine isotopes into thyroids. This was not done at Chernobyl but appears to have been successfully implemented at Fukushima.

No-one has died due to radiation exposure from the damaged reactors at Fukushima and no member of the public is likely to die from radiation exposure. As at Chernobyl, however, there have been major physical and psychological health problems due to the evacuation and to unwarranted and exaggerated fears of radiation. Stigma and depression have been added to fear, leading to suicides. There have been numerous deaths of elderly people, in particular, who have been ripped out of their homes, nursing homes and hospitals, and moved from place to place.

Some workers at the Fukushima Daiichi nuclear power station received significant doses of radiation. The exact size of the delayed health risk to workers is again a matter of controversy: probably more than 10

OCEAN CONTROLS
Helping to put you in Control
Control Equipment

Synapse/XBee Breakout Board
Small breakout board for XBee/Synapse RF266 modules. On-board 3.3v regulator, 2 relay outputs, 2 analog inputs, 3 Digital Input, 1 O.C. output. 12 VDC powered.
KTA-281 $79+GST

Terminal with 250 Ω Resistor
DIN Rail mount terminals are fitted with 0.1% precision 250 Ω wire wound 0.125 W resistor. Suitable for converting a 4-20 mA signals to 1-5 VDC
TRM-171 $12.95+GST

Arduino K-type T/C MUX Shield
Add up to 8 K-type T/C to an Arduino. Powered from 3.3V Arduino pin, 5 V compatible. J,N,S,T,E,R T/C supported.
KTA-259K $44.50+GST

LabJack Digit-TL
Is a Temp/Light logger which can store up to 260K readings, a battery life of 3 years & IP68 enclosure. Download data via USB.
LAJ-060 $56+GST

N321S Differential Temp Controller
240 VAC powered. RS-485 interface with Modbus RTU protocol. 2 relay outputs. 3 m NTC sensor probe incl. Configuration via pushbuttons.
CET-031 $89+GST

Magnetic Fixing Temp. Probe
Measure Temp. of steel surfaces using these RTD probes. Range –50 to 200 degC. T/C probes also available.
CMS-007 $79.95+GST

DIN Rail Mount Temp. Controller
T/C and RTD(PT100) input. Accuracy: ±0.3%. Relay and Alarm output. PID features. Serial communication with RTU Modbus protocol.
CPM-200 $190+GST

Contact Ocean Controls
Ph: 03 9782 5882
oceancontrols.com.au

Mailbag: continued

AM broadcast quality not what it used to be

As a retired engineer I'd like to respond to Bram Taylor's letter in the April 2013 issue, specifically with reference to his interest in wide band AM radio reception.

In the days when I was associated with AM broadcasting, most Chief Engineers were very conscious of their station's "sound" and many maintained a transmitted audio bandwidth in excess of 10kHz. Nowadays, the ACMA recommendation is that the audio frequency response of an AM transmitter should be "... nominally flat over the range of 50 Hz to 7 kHz." (Technical Planning Guidelines 2007).

Regardless of the upper limit of the transmitted audio bandwidth, the tragedy is that the vast majority of AM receivers favoured selectivity and sensitivity at the expense of an accurate, low distortion recovery of the transmitted audio. With a few marvellous exceptions – such as the AWA Orthofidelity AM3 tuner from the early 1970s, if you wanted to recover the full transmitted AM bandwidth with minimum interference, you needed to live fairly close to the transmitter and be prepared to "roll your own."

While the local electronics magazines often featured high-performance AM tuners, it was the advent of AM stereo in the mid-1980s which saw the arrival of commercial wideband AM tuners with selectable IF bandwidths and 9kHz whistle filters. Later, as in the high-end American Fanfare FTA-100, low distortion synchronous demodulators were used. Models appeared (all too briefly) from Sony, JBL, Carver etc but the ensuing total lack of industry support for AM stereo eventually contributed to its demise.

As an aside, I still have a working Sony JX-230A AM stereo tuner, and up until the advent of DAB+ broadcasting, even AM Mono reception (especially on Radio National and our local AM music station Magic 1278) sounded very good.

While all radio stations corrected(!) their audio baseband prior to transmission by devices such as Optimod Signal Processors, since the introduction of DAB+ there's no doubt in my mind that modern engineers have been obliged to re-tweak their audio basebands. This is possibly because they are trying to cram too many programs into their slice of digital bandwidth – handling multiple program data streams requires low data bit rates. At the typical bit rate of 32-48kb/s, the resulting sound quality is not good.

This has resulted in what I would describe as a "bright and flat" sound with little real audio top end. In fact, a present-day comparison for the same program received via AM, and then listening via DAB+, reveals (to me, anyway) that the DAB+ sound is inferior.

Perhaps Silicon Chip could confirm my suspicions by having a chat to some current practising AM transmitter engineers? And while you're at it, why not suggest that they crank up their data bit rates!

Norman Hughes,
Flinders, Vic.

and possibly more than 100 of them have incurred an average 2% risk of eventually dying from cancer. This is in addition to the normal average cancer fatality risk of about 25% for people who have not been accidentally exposed to radiation.

The nuclear plants at Chernobyl and Fukushima had major shortcomings in design that were recognised before the accidents occurred. Engineers learn from experience (and, hopefully, the directors of power companies too) and plants that would be built in Australia today would be much safer. Unlike the Chernobyl reactor, they would have containments and they would be designed to counter potential flooding.

Danilov's claim that these reactor accidents "resulted in thousands of deaths (and more to come)" can only be based on the application (misapplication) of the linear no-threshold (LNT) model of risk estimation. This LNT model has itself caused many people to believe, mistakenly, that there is no safe dose of radiation. If that were true, we would not be here because we are all exposed to natural background radiation.

The LNT model is recommended by the International Commission on Radiological Protection (ICRP) for use in the optimisation of radiation protection practices. The ICRP specifically states that it should not be used for estimating numbers of casualties from exposures of many people to small doses.

Danilov may not be aware that the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) has recently recommended that the LNT model should not be applied at all to doses up to the levels of natural background radiation. (Or perhaps he is "in denial" about this development.) It has been estimated that few if any members of the public at Fukushima would have been likely to have incurred doses greater than 30mSv in a year from the reactor accident even if there had been no evacuation. Natural background levels range around the world up to more than 30mSv per year without causing any discernible harm.

Danilov's claim of a "huge increase in cancer rates among all uranium mine workers and those people living within a large radius of an existing nuclear power station" is completely without foundation. Even at Chernobyl, after the reactor accident in 1986, the second part of this statement was not true.

For uranium mine workers, there was a discernible increase in incidences of lung cancer from inhalation of radon many years ago, before this risk was properly recognised. Appropriate controls are now in place and the greatest risk – from mining – to the lungs of the workers is silicosis, as it is for many other mine workers. To put this into perspective, smoking causes a much greater risk for those who smoke.

A study covering almost 700,000 US shipyard workers, carried out between 1980 and 1988, showed that mortality rates from all causes and from all cancers were lower for the workers on

nuclear powered warships than for those doing identical work on conventional warships. A much quoted study of land-based nuclear industry workers, published by the International Agency for Research on Cancer in 2005, purported to show a statistically significant increase in the risk of mortality from all cancers excluding leukemia in relation to radiation exposure. A rarely quoted re-analysis of the data subsequently showed that there was no such effect.

Danilov's other arguments are also groundless or misleading, viz: the problem of radioactive waste disposal is political not technical. Technologies exist for safe disposal and Australia has some of the best sites in the world for this purpose. All industries for generating electricity have environmental impacts, including mining for fuel and raw materials and pollution. The nature of these impacts differ from one industry to another but they are minimal for nuclear power.

A nuclear power station is expensive to build and takes longer to build than some other types of power station but it is cheap to operate. In the long term, nuclear power is one of the cheapest ways to generate electricity with minimal emissions of greenhouse gases. Where is the evidence that nuclear power stations "kill millions of fish and damage the marine environment" compared with other thermal power stations using sea-water cooling?

In case Danilov wants to question my areas of expertise, I am a Fellow of the Australasian Radiation Protection Society and a Fellow of the Institution of Engineers Australia. I advocate the use of nuclear power because I have studied the matter, and I consider it to be safe, economically sustainable and the most environmentally friendly way to generate most of the electricity that the world needs.

Dr Don Higson,
Paddington, NSW.

Safety of nuclear power

In view of Alex Danilov's letter on the supposed dangers of nuclear power, here are a number of recent stories that put the opposite case. Sure, these my be regarded as pro-nuclear propaganda but the claims cannot be ignored.

First is the study by James Hansen and Pushker Kharecha, entitled "Life-saving case for Nuclear". See **www.world-nuclear-news.org/EE Life saving case for nuclear 0304131.html**

James Hansen is an unlikely "promoter" of nuclear power. One of the things unstated in the article is that, now that both Germany and Japan have shut down their nuclear fleet, what will be the increase in death rates that might be attributable to the inevitable increased use of fossil fuels?

The second is a report on the likely long-term effects of the Fukushima disaster. Answer: with simple precautions, not much – **www.world-nuclear-news.org/EE Life saving case for nuclear 0304131.html**

Thirdly, here is a report on the excellence of the safety culture in the US nuclear industry – **www.world-nuclear-news.org/RS-US nuclear safety goes from strength to strength-1204137.html**

COMPLETE 12 CHANNEL
433MHz MULTI-FUNCTION
Longreach Remote Control Set

It's all ready to go! The **KSRC12-1T1R-MTL** has **12 x 500W relays** that can be set to Momentary, Toggle (Push ON-Push OFF), or Latch/De-latch

Use the **KSRC12-1T1R-MTL** in call systems, appliance, lighting, scoreboard UP/DOWN control, gate and model control over 100s of metres.(line-of-sight)

Yours Now!! $67.70 inc. GST Plus $7.50 Pack & Post

Tiny, Wide Range 3.0Amp
DC-DC Buck Converter

At this price you can afford a few of our **KS2596s** for your parts drawer.
Input Voltage: DC 4V to 35V
Output Voltage: DC 1.5V to 35V (adj.)
COMPACT 52mm x 20mm x 15mm

Value!! $6.70 inc. GST Plus $4.60 Pack & Post

KitStop
electronics – the fun starts here

For details and to buy on-line
www.kitstop.com.au
P.O. Box 5422 Clayton Vic.3168
Tel:0432 502 755

The fourth one is a reality check. Nations around the world, particularly in Asia are voting in favour of nuclear power. See: **www.world-nuclear-news.org/NP-Positive outlook for nuclear energy-1004131.html**

Just one more: this is one example of what the US nuclear industry has been doing, quite legitimately since Jimmy Carter's ban on new nuclear plants. They have been upgrading and uprating existing reactors. I saw recently that the US has effectively installed some 6800MW of new nuclear power during those years simply by upgrading existing reactors. That's a figure not to be sneezed at. In the pipeline there are requests of the US NRC for a similarly-sized additional amount. That's without building a single new reactor.

And unlike fickle wind power, that's all going to service the all-important base load requirement. Two related links are:

world-nuclear-news.org/C-Uprates complete at Florida plants-2204137.html

www.nrc.gov/reactors/operating/licensing/power-uprates/status-power-apps.html

Meanwhile, construction on the first new reactor in the US for 30 years has been commenced. See: **www.world-nuclear-news.org/NN-AP1000 construction underway at Summer-1203134.html**

Paul Miskelly,
Mittagong, NSW. SC

The assembly lines in the Quantity Production Works, Ashfield, NSW during WW2. Domestic radio production was heavily limited during the war years in favour of military production.

100 Years of AWA

By KEVIN POULTER

Australia's biggest & best electronics company

It's now 100 years since the formation of Amalgamated Wireless Australasia Ltd (AWA), the most significant and important radio company ever to exist in Australia. Here's a quick look at those early years.

AWA WAS FOUNDED in 1913 by Ernest Thomas (E. T.) Fisk, later known as Sir Ernest Fisk. Fisk's career began earlier in England as a humble newspaper seller on a railway station in Middlesex. He subsequently graduated in engineering in the works of Frederick Walton, then joined the British Post Office as a wireless telegraphist.

It's interesting to note that Fisk's early drive, determination and business directions were similar to Thomas Edison's. Edison also started out by selling newspapers (on a train) before going on to work in telegraphy.

Radio-telegraphy was introduced into England by Marconi in 1896. At that time, it was accepted that spark transmitters broadcast over such a wide spectrum that only one radio channel was possible world-wide!

Marconi's work inspired Fisk to join the Marconi training school in 1906, learning Morse and wireless telegraphy, then qualifying as a radio engineer and operator. In 1909, he went to work for American Marconi, initially demonstrating wireless to Newfoundland sealers and on the St Lawrence River. This was then followed by a stint at Marconi's headquarters in London.

Wireless in Australia

Wireless communication was officially recognised by the Australian Commonwealth Government in the Wireless Telegraph Act of 1905. Initially, wireless telegraphy was only used on warships. Then, in 1906, C. P. Bartholomew erected an experimental station at Mosman near Sydney, establishing communications using equipment he built himself.

The growing potential of wireless in Australia soon attracted the Marconi Organisation's interest. As a result, Fisk was briefly despatched to Australia in 1910 to demonstrate Marconi apparatus. At about the same time, the first association of "Wireless Experimenters in the British Empire"

Sir Ernest Fisk with early "wireless" equipment. Fisk founded AWA in 1913.

The AWA logo style was little changed over the years.

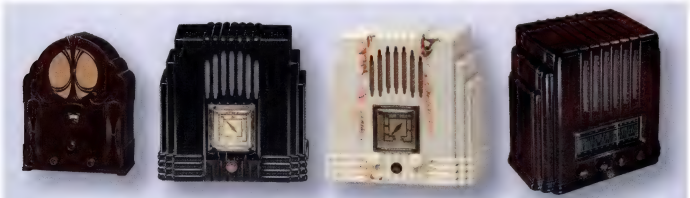
The valve radios made by AWA and other manufacturers kept an army of servicemen clothed and fed. This Manly-based Woodward's Radio Service van circa 1946 had a rear canopy that was custom-built to resemble a console radio.

was established in Sydney as "The Wireless Institute of NSW". The founder, George A. Taylor, was also involved in the development of wireless telegraphy, eg, between the front and the rear of a train and between trains running at full speed.

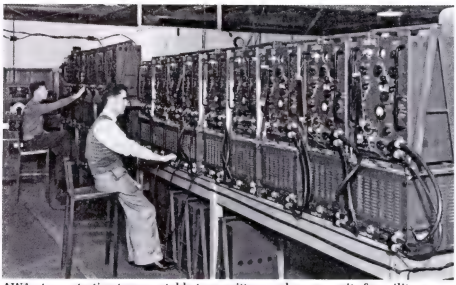
It's fair to say that the few transmissions at that time were mainly by amateur enthusiasts.

The Federal Government, acting on a report from Admiral Henderson, subsequently invited tenders for the construction of a wireless telegraph station in Sydney and another in Perth – each to have a daylight range of 2000km. Fisk returned to Australia in 1911 to again promote the Marconi equipment but unfortunately for his company, a contract was subsequently signed with the lowest tenderer, Gesellschaft fur drahtlose Telegraphie System (Telefunken) of Berlin, for the construction of these stations. Engineers and apparatus were shipped from Germany and the stations were erected during 1912 and 1913, one at Pennant Hills in Sydney and the other at Applecross near Fremantle.

When the SS Titanic sank in 1912, shipping companies quickly realised that "wireless" had the potential to avert similar disasters. This generated renewed interest in further installations and during 1913 and 1914, a number of smaller stations were erected around the Australian coast at Melbourne, Hobart, Mt Gambier,

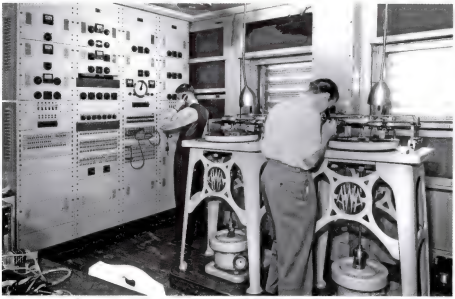


A selection of 1930s AWA radios in bakelite cases: at left is a C87 AWA Fisk Radiolette circa 1932, while at centre are two Fisk Radiolette Empire State radios from the mid 1930s. The set at right is a Radiola R52 Big Brother circa 1938.

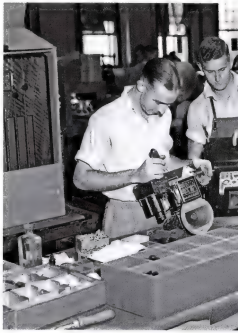


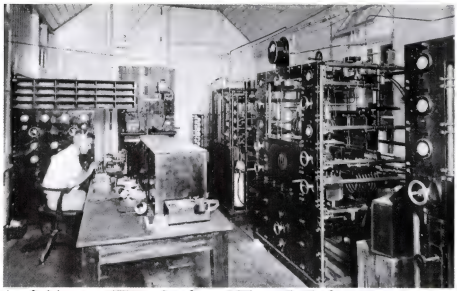
AWA at war: testing transportable transmitters and power units for military ground stations during 1943.

Above: valve-manufacturing during the 1920s. AWA manufactured many thousands of pre-war domestic radios.



Above: record cuttting lathes at AWA's Ashfield plant in January 1947.





A technician at an AWA-equipped transmitting station in the 1920s.

Port Adelaide, Esperance, Geraldton, Roebourne, Wyndham, Port Darwin, Thursday Island, Port Moresby, Townsville, Cooktown and Brisbane.

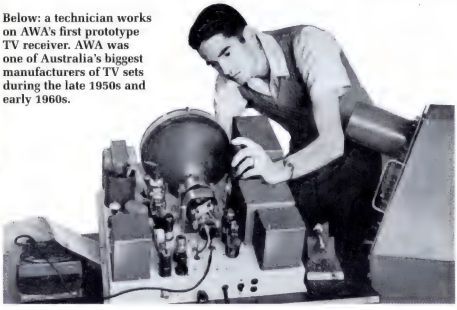
AWA formed

Based on this expanded interest, Amalgamated Wireless (Australasia) Ltd was formed in 1913 with an injection of 140,000 pounds of Australian and English capital. Ernest Fisk was a foundation director and was also the General and Technical Manager. He was subsequently appointed as AWA's Managing Director in 1916.

Below: assembling AWA Fisk Radiolette "fret and foot" radios, circa 1936. Photograph by Max Dupain.

Radiotron Valves being made at AWA's Ashfield plant during 1939. AWA made vast numbers of valves, both for their own radios and for many other radio (and later TV) manufacturers. Photo: Max Dupain.

Below: a technician works on AWA's first prototype TV receiver. AWA was one of Australia's biggest manufacturers of TV sets during the late 1950s and early 1960s.



Following its launch, AWA immediately purchased existing and future patent rights for the Marconi and Telefunken systems. During WW1 (1914-18), AWA developed and manufactured equipment for the Australian mercantile marine and for British vessels built in Japan and China for the British Ministry of Shipping.

The company was also involved in intercepting wireless messages from enemy ships in the Pacific and eventually from European stations in Germany, Italy, France and England. For example, wireless signals from Germany were intercepted in 1917 at the Naval Wireless Station in Applecross, WA. These intercepts often provided valuable intelligence.

England to Australia

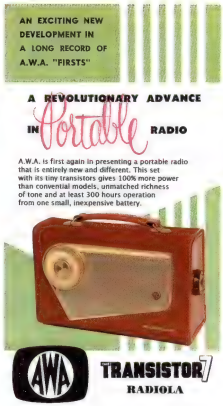
In 1918, just before the end of the war, AWA received a series of test messages from the Marconi Trans-Atlantic Station at Carnarvon in Wales, UK. These experiments were completed on September 22, 1918, when the first direct wireless message from England to Australia was received at Wahroonga near Sydney.

Eleven months later, on August 13, 1919, the first public demonstration of wireless telegraphy occurred in the Royal Society's building in Sydney. Another demonstration was made on October 13, 1920 in the Queens Hall of the Federal Parliament House in Melbourne.

The Government took years to decide what to do with wireless. From 1905-1915, the administration of the Wireless Telegraph Act was in the hands of the Federal Postmaster-General. Then, in 1915, it was transferred to the Minister for the Navy before be-

Above: the 1947 AWA Radiola 510M. This 5-valve dual-wave set was housed in a bakelite cabinet and was available in ivory, jade green and walnut.

Built in York St, Sydney, by AWA as its head office in 1939, Wireless House with its 48.5-metre steel tower was the tallest building in Sydney until the 1960s.



Released in December 1957, AWA's Radiola Transistor 7 was the first completely Australian-made transistor radio. It featured a 7x5-inch loudspeaker and had a claimed battery life of 300 hours. Earlier transistor radios in Australia were made using sub-assemblies and parts from overseas or were fully imported.

ing returned to the Postmaster-General in 1920.

Radio broadcasting

With the advent of broadcasting in 1923, a large number of Marconi School graduates entered the field of radio, occupying positions as service mechanics, as technicians at broadcasting stations and in sales. George Taylor continued to play a leading role. On May 24, 1923, he chaired a conference of all parties interested in wireless broadcasting in Melbourne. A provisional scheme was adopted involving the use of sealed sets, whereby listeners could only hear the one station that their set was tuned to.

After a trial, this (rather silly) idea was discarded, as people clearly wanted a choice of radio stations.

The scheme finally adopted was designed to give full freedom in the establishment and running of broad-

The AWA C54 console – a 6-valve battery-powered TRF receiver from 1929. Photo: Leith Tebbit.

An advert for AWA's portable C25 Radiola Super (Sports Model). This 6-valve superhet receiver was first manufactured in 1925.

casting services, while avoiding the evident problems that had arisen with American and English broadcasting. This included concessions by the Government to persons or firms in order to establish broadcasting on a competitive basis, licensing of private individuals to transmit for experimental purposes, and allowing others to use wireless apparatus for receiving any services. It also involved licensing manufacturers and traders to deal in "wireless apparatus" for broadcasting purposes.

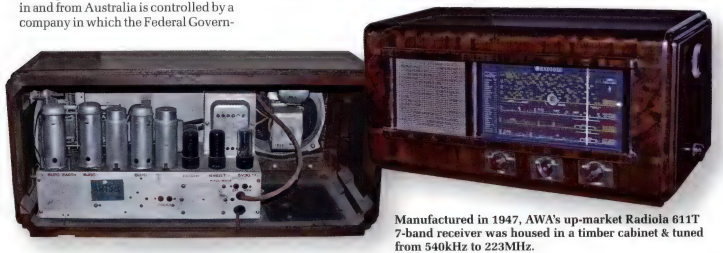
In 1926, Fisk wrote: "Private Wireless Stations are now allowed under licence from the Postmaster-General, but all public wireless communication in and from Australia is controlled by a company in which the Federal Government appoints a majority of Directors and holds a majority of the shares.

"The Amalgamated Wireless Ltd must by the terms of the agreement under which it exists remain a British concern, not connected with any trust or combine. It will erect and operate (a) Main Power Stations for direct service with the United Kingdom, (b) Feeder Stations connecting the main stations with the Federal and State capitals, (c) Coastal Stations, where required, to maintain communication with vessels off the coast, and (d) certain stations in Papua and the neighbouring Islands.

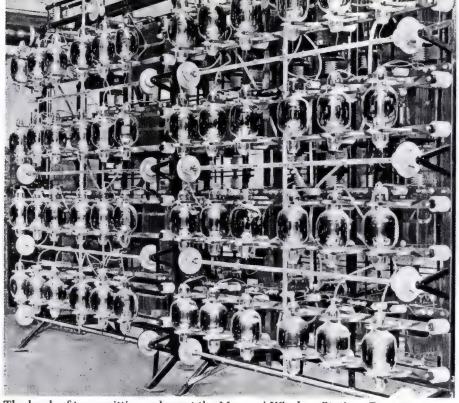
"It will also arrange the provision of stations in the United Kingdom and Canada capable of maintaining direct communication with Australia. The rates will be, roughly speaking, 2/3 of those charged for cable messages. Existing Commonwealth Stations are taken over".

In 1927, a "beam" service between Australia and Britain was inaugurated, undercutting the cable companies. Then in 1928, the Australia-Canada service began, followed in 1930 by an Empire radio-telephone service. In 1931, the great radio pioneer, Marconi, was made godfather to Fisk's fourth son, David Sarnoff Marconi Fisk.

Fisk was appointed Chairman of AWA in 1932, yet another major achievement for a one-time newspaper seller. This was also the year that AWA



Manufactured in 1947, AWA's up-market Radiola 611T 7-band receiver was housed in a timber cabinet & tuned from 540kHz to 223MHz.



The bank of transmitting valves at the Marconi Wireless Station, Carnarvon Wales, used for direct communication with Australia.

became the first company in Australia to introduce a bakelite cabinet radio, the Radiolette C87 Cathedral and GE 40 (AGE) version.

Fisk knighted

Knighted in the Coronation honours of 1937, the now proudly-Australian Fisk joined many societies and clubs and a number of influential boards but still found the time and energy to continue promoting the wireless industry.

In the early 1940s, Fisk envisioned a boundless future for wireless. He said that it even raised hopes for an international language and that he saw the possibility of using it to communicate with the dead (he had always been interested in spiritualism)!

By 1944, AWA had 6000 employees and a turnover exceeding four million pounds, making it one of Australia's most powerful organisations. That same year, Fisk stepped down from AWA to become Managing Director and Chief Executive of the Electrical and Musical Industries (HMV) group in London. He subsequently returned to Sydney in 1952, working as a consultant in commerce, industry and technology.

Growth & turmoil

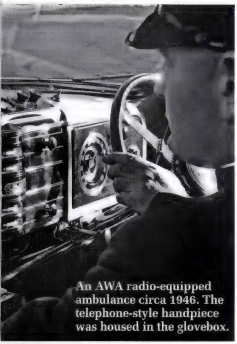
During the 1920s and 1930s, AWA made virtually everything in-house, including screws, resistors and foil capacitors but after WW2, the latter were mostly sourced from IRC and Ducon. AWA's in-house manufacturing supplied a massive range of parts for Radiola domestic radios, transmitters, instruments and equipment. The company also became the industry supplier for valves of all types, TV picture tubes, image orthicons for video cameras, semiconductors, quartz crystals, integrated circuits (ICs), tuning gangs, press-button tuners for radios (especially car radios), TV turret tuners, all types of switches, vibrators, emergency lighting components, transformers (power, audio & isolation etc), EHT transformers and deflection coils for TV sets, ballasts, coil sets for radios (IF, RF, oscillator, aerial and tuning coils) and loudspeakers of all shapes and sizes.

AWA also had some of the largest specialised injection moulding presses in Australia. Bakelite moulding was a speciality and included control knobs and cabinets for radios, telephone handsets and various parts for Sunbeam and Hotpoint appliances. In addition, their machine-shop produced all sorts of metalwork, including radio chassis, component parts for tuners, switches and lighting, brackets and special screws and nuts that were unique to AWA.

Those products intended for use by AWA in-house were branded "AWA", while those supplied to other manufacturers were generally sold under the "MSP" label (Manufacturers Special Products), eg, loudspeakers. In the year before the Whitlam Government removed tariffs in the 1970s, AWA manufactured approximately 975,000 loudspeakers.

Along with domestic radio and TV manufacture, AWA continued to grow their product range in the 1950s and

AWA manufactured a wide range of test equipment, both for internal use and the general market. This solid-state audio oscillator covered from 10Hz-30kHz. Photo: Graham Parslow.



An AWA radio-equipped ambulance circa 1946. The telephone-style handpiece was housed in the glovebox.

beyond, with devices such as 2-way radios, transistors, ICs, telephones, avionics and test gear. Sir Ernest Fisk had guided AWA though a minefield of political and commercial challenges, to be one of the most successful Australian companies ever.

It was often said that because AWA made all parts in-house, they were exposed to a constant drain on profit and capital. It was an approach that required continuous reinvestment in design, equipment, maintenance, service and more.

The winding back of tariffs in the 1970s eventually ended domestic radio and TV manufacture and AWA subsequently experienced a period of turmoil in 1987 when it reported a $49 million foreign exchange loss due to unauthorised trading. This was then followed by years of legal wrangling between the auditors (for failing to identify the trading) and the company.

In May 2010, the employee at the centre of the foreign exchange losses, Andrew Koval, was extradited from the United States to face criminal charges. He had previously defended a civil suit in relation to the matter and was eventually given a bond.

In 1987, the company was renamed AWA Limited and in 1988 sold its telephone manufacturing and related businesses and closed its main manufacturing facility, Radio Electric Works, at Ashfield. A year later, AWA Computer Support Services was established as an independent business unit. AWA also established AWASCo Pty Ltd during the 1980s. This was a joint venture with Serco Group of the UK and eventually Serco purchased AWA's share to form Serco Australia.

In the early 1990s, unable to compete with lower-cost imports, AWA exited the field of domestic products and consumer electronics to focus on industrial technology. The company subsequently grew its export business to over $90 million per annum by selling its infrastructure systems (traffic control, air navigation and digital microwave telecommunications equipment) to countries such as China, Indonesia, The Philippines and Argentina.

In addition, AWA successfully launched a Keno on-line game into over 800 registered clubs in NSW and Victoria (the world's largest on-line game). It also continued to develop sophisticated technology for the Australian Defence Force.

AWA made telephones for many years. This 1976 ice-blue AWA 800 wall phone recently sold for $366.

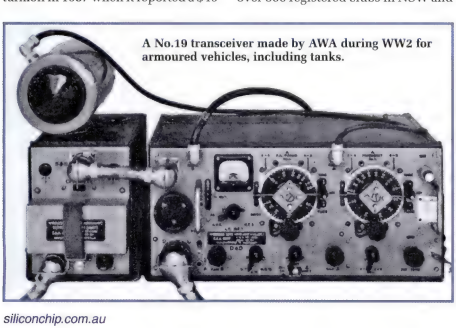
In 1991, AWA acquired Smorgon Technologies, a world leader in totalisator systems. The company subsequently developed and operated state-of-art wagering systems that were installed around the world.

The break-up and sale of various AWA divisions in the period from 1994-97 was driven by a decision to maximise the return to shareholders. In 2001, AWA was acquired by Jupiters Limited which itself was soon merged with Tabcorp. Then in 2004, the company was spun off and once again became an independent company.

In 2006, AWA acquired Telefix Sales Pty Ltd, which had been servicing home entertainment products since early 1960. Today, AWA employs close to 300 staff, and utilises 700 agents in regional Australia to manage its service obligations to many blue-chip companies. This includes service for:

(1) network hardware and ancillary equipment;
(2) servers, desktop PCs, laptops, displays, printers and peripherals;
(3) specialist equipment such as EFTPOS machines, lottery terminals, digital photo kiosks, health-related technologies and library systems;
(4) IP telecommunications and wireless communications; and
(5) Home entertainment equipment and home networks.

References: John McIlwaine, AWA Veterans' Archives plus others listed at www.aaa1.biz/sc SC



A No.19 transceiver made by AWA during WW2 for armoured vehicles, including tanks.

Cheap and cheerful Smart TV Conversion

By Julian James

Why buy a smart TV when you can do this simple work-around with your existing TV. You could end up with a smarter TV than a smart TV!

I **recently converted my non-smart** TV (a Panasonic TX-32LXD70A) to a smart TV using a Raspberry Pi with the XBMC program (www.XMBC.org).

This worked OK but the Catch-Up TV sites I wanted to watch (www.freeview.com.au/tvguide/CatchUp.aspx) have a more limited choice for Linux and Apple-based computers than their Windows counterparts. They also cannot support a proxy server to enable overseas TV channels to be streamed.

This meant investing in a PC for the purpose. As I wanted a small set-top-box style of computer, I chose the Acer Veriton 1000 for its small size, measuring only 250mm high x 60mm wide and 200mm deep and having a separate "brick type" power supply which can be easily hidden.

While it was being offered for sale by various ebay suppliers, I found one at Mission Australia's Bellambi (NSW) store, which has a good IT department and has "pre-loved" computer packages from $100 upward.

So I bought an Acer Veriton 1000 1.8GHz small-form-factor computer from them for $100 and connected this to my TV via the PC and the TV's VGA sockets.

Last issue, where Leo Simpson looked at using a large-screen smart TV as a computer monitor, he came to the conclusion that smart TVs weren't all that smart!

In fact, he commented "*you quickly come to the conclusion that a good laptop or desktop PC is far superior (to a smart TV) in virtually every aspect*".

This article, then, is very timely: it shows you how to get the best of both worlds – the power of the computer and the size/clarity/convenience of a large-screen modern TV set.

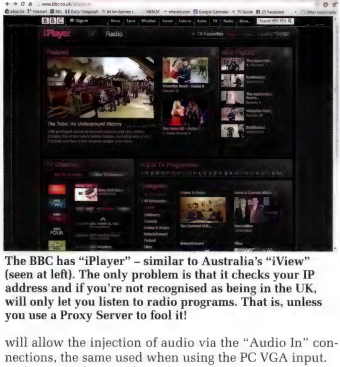
The audio was connected from the audio output on the computer to the "Audio Input" on the TV, using a 3.5mm stereo jack to 2x RCA connector lead.

This worked but the streaming program it displayed as a letterbox view, which made the actors somewhat squat and fat.

The answer was to use the DVI-D output from the computer and connect to the TV with a DVI-D to HDMI converter (costing less than $3 post free from Ausutek on ebay) and an HDMI cable.

On my Panasonic TV there are two HDMI inputs. The first (HDMI1)

The DVI-D output on the PC (black plug at top) connects to the HDMI input on the TV set via a (cheap!) DVI-D to HDMI converter and HDMI cable. The audio out socket could be used to connect to a hifi amplifier.

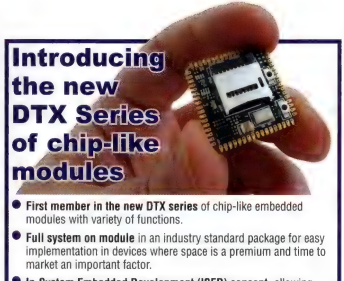


The BBC has "iPlayer" – similar to Australia's "iView" (seen at left). The only problem is that it checks your IP address and if you're not recognised as being in the UK, will only let you listen to radio programs. That is, unless you use a Proxy Server to fool it!

will allow the injection of audio via the "Audio In" connections, the same used when using the PC VGA input.

If your TV does not have this facility then a connection to a stereo system or a pair of computer speakers would also work.

Using the HDMI connection has the advantage of being able to select an aspect ratio that shows the programs at full screen.



- **First member in the new DTX series** of chip-like embedded modules with variety of functions.
- **Full system on module** in an industry standard package for easy implementation in devices where space is a premium and time to market an important factor.
- **In-System Embedded Development (ISED) concept**, allowing software development directly onto the target hardware without the need of external development tools such as compiler, debugger/programmer, cables, etc.
- **The whole DTX series is designed with the consideration for low-power applications.** It is also "everyone for themselves" type, where every module has its own power converter thus significantly increasing the overall system reliability.

For more information: contacts@dimitech.com

DIMITECH

435-437 Nepean Hwy, Frankston VIC 3199

Phone: (03) 90168919 Fax: (03) 99232709

Just what is a "Smart TV"?

It's one of the buzz-words of the decade. But what is a "Smart TV" and how does that differ from the TV you've enjoyed for decades (well, since 1956 in Australia!)?

In as simple a definition as possible, a Smart TV is a TV set with an inbuilt computer, which enables it to access a variety of services that a "normal" TV cannot. Obviously all that an older TV is capable of displaying is programming it receives either off-air via its antenna, or is fed to it from some form of video player/recorder or, for example, from a Pay-TV decoder.

It's that last item, the Pay-TV decoder, that allows a standard TV (for want of a better description) to behave, at least to some extent, like a Smart TV, because it enables you to time-shift, slow down and speed up action, and so on.

But a "real" Smart TV can do much more than this. Because it is connected to the internet, via a wired (Ethernet) connection or perhaps a wireless link, the Smart TV can interactively display just about anything that you can get from or do with the 'net. That includes watching "streamed" video from a huge variety of sources – whether that be downloaded movies, brief snippets such as you find onYouTube, even displaying web pages and so on. You can even use a Smart TV as your main audio device as well, playing music (downloaded or on your hard drive), running internet radio stations etc. It can run that other buzz-word of the moment, "apps" (or applications).

And let's not forget some of the most amazing games you'll ever see/play! All this with remote control.

We mentioned the word "interactive" a moment ago because a Smart TV, with its inbuilt computer, becomes an input device as well as a display device.

With appropriate hardware connected (eg, a mouse, keyboard, etc – although even these aren't strictly necessary as they can be simulated on screen) you can do nearly as much as you can with a typical computer and monitor– even such mundane tasks as word processing and emailing!

Smart TVs are becoming more "the norm" these days and are taking their place as centres of entertainment in the home – with capabilities way beyond what the old square box in the corner could ever do!

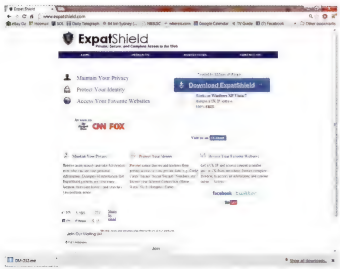
Do you need to upgrade to a Smart TV?

Not if all you want to do is watch TV programs – free-to-air via the antenna, or cable if you have it. Your old TV will continue to do this more than adequately (assuming, of course, it's digital-ready or you have purchased a digital set-top-box).

Can you upgrade an existing TV?

The answer is yes, with reservations – after all, that is what this article is all about. But if you want to take advantage of more of the whizz-bang features of Smart TV, you're eather going to have to load more software into the PC and connect it as described here, or another route is to obtain a "media centre" (they're quite cheap these days) and use that.

You could also buy a set-top-box which has Smart TV capability and, quite likely, PVR (personal video recorder) facilities as well. You'll almost certainly need a much more capable remote control but most set-top-boxes come with these anyway.



Here's the "ExpatShield" proxy server – one of the most popular and very easy to use. But don't forget to log out if you want to watch Australian programs, because they will think you're outside Australia and stop you watching, just like iPlayer does!

There are various zoom views but I chose the "Just" option as this reduced the cropping of the picture.

I made the toolbar at the bottom of the screen taller so it showed the "Start" and "Minimised" Screen tabs, for easier operation. These disappear during streaming.

I used the 32-bit (highest) colour quality and 1280x720 pixel screen resolutions.

These refurbished computers come with Windows XP, free virus and other programs. As I am only going to use this for streaming catch-up TV and YouTube, I removed all the shortcuts to the programs that I would not be using and then created shortcuts to ABC, SBS, Channel 7 etc.

So now it's just a matter of selecting the required channel and program and off you go.

Overseas programs

If an overseas channel is required then it must be accessed via a proxy server and a Google search is required to find one in the chosen country. Some of these may charge a subscription, which start at around $5 per month.

I like the BBC (UK) iPlayer channel but to view this channel here in Australia it must also be accessed via a proxy server.

The easiest one to use is the "Expat Shield" (**www.expatshield.com**). This is a free download but only works for PCs at the moment.

Once it's downloaded it can be connected via the shortcut or the shield icon in the computer's tray.

When connected it assigns a UK IP address to the computer. This makes the computer appear to be in the UK – if it has an Australian (or other) IP address it won't work.

After connection, the tab can then be closed and any search will be via the proxy server. A connection can then be established to the UK online TV channels.

Streaming from the UK via this proxy server can sometimes be slow and seems to depend on the time of day, The BBC offers HD quality streaming on some programs and this can stall sometimes, but generally it will work.

There is a downside: don't try to connect to any Australian channels as while running Expat Shield. Again, it wont work, as the reverse applies and it thinks you are in the UK!

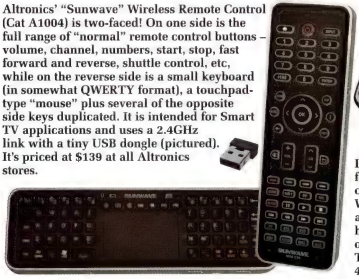
The other problem with Expat Shield is popup adverts, although these can be stopped by using Firefox and their "anti popup" add on.

The BBC iPlayer (**www.bbc.co.uk/iplayer/tv**) won't let you watch TV programs if you are not domiciled in the UK (due to rights restrictions – it checks your IP address) but it does have a radio streaming service which has comedy shows, plays, documentaries etc. These can be accessed directly without the need for a proxy server.

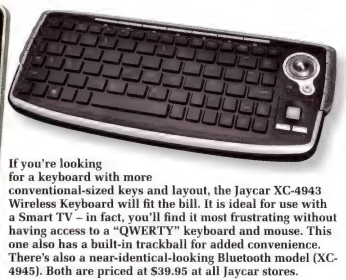
Once this has been set up, you only need a mouse to navigate the screen, but I opted for a wireless keyboard with trackball from Jaycar (Cat No XC-4943) which worked well.

It is very tempting to remove the stand from the Acer and position it sideways in the TV cabinet's DVD compartment but I found in this limited area the Acer got rather too hot for comfort, so I positioned it upright on its stand behind the TV. The wireless keyboard still worked well in this position and it's nicely out of sight.

So there you have it: a smart TV conversion for a little over $100, which is smarter than the average Smart TV as it can access overseas online TV sites. SC



Altronics' "Sunwave" Wireless Remote Control (Cat A1004) is two-faced! On one side is the full range of "normal" remote control buttons – volume, channel, numbers, start, stop, fast forward and reverse, shuttle control, etc, while on the reverse side is a small keyboard (in somewhat QWERTY format), a touchpad-type "mouse" plus several of the opposite side keys duplicated. It is intended for Smart TV applications and uses a 2.4GHz link with a tiny USB dongle (pictured). It's priced at $139 at all Altronics stores.



If you're looking for a keyboard with more conventional-sized keys and layout, the Jaycar XC-4943 Wireless Keyboard will fit the bill. It is ideal for use with a Smart TV – in fact, you'll find it most frustrating without having access to a "QWERTY" keyboard and mouse. This one also has a built-in trackball for added convenience. There's also a near-identical-looking Bluetooth model (XC-4945). Both are priced at $39.95 at all Jaycar stores.

Design-In Advanced Graphics Displays Quickly and Easily

Microchip Technology's display solutions offer the ability to quickly integrate graphics display functions into existing applications in a single microcontroller—reducing development risk, total system cost and time to market. The PIC® MCUs can drive everything from simple monochrome LCDs to full color WVGA user interfaces.

The PIC24F "DA" family features hardware acceleration and an integrated graphics controller to directly drive a graphical display. The "DA" family includes USB and touch interfaces as well as 96 KB of RAM to store the frame buffer, eliminating the need for external memory.

PIC32 controllerless graphics solution uses the high performance DMA to render graphics directly to graphical displays without the need for an external graphics controller. The PIC32 family includes up to 128 KB RAM for frame buffering and also integrates touch, USB, Ethernet and CAN for remote interfaces.

MICROCHIP MAKES IT EASY TO EMBED GRAPHICS INTO YOUR NEXT DESIGN:

1. **Free Graphics Library** – with full source code, includes buttons, charts, scroll bars, images and support for multiple fonts & languages
2. **Free Graphics Display Designer Visual Design Tool** – simplifies code development and generates output source files
3. Flexible hardware development kits allow interface to various glass sizes.

www.microchip.com/graphics

microchip DIRECT
www.microchipdirect.com

Microchip Technology Australia
Tel: (02) 9868 6733 E-mail: aust_nz.inquiry@microchip.com

MICROCHIP

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

The Microchip name and logo, the Microchip logo and PIC® logo are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. All other trademarks mentioned herein are property of their respective companies.
© 2013 Microchip Technology Incorporated. All rights reserved.

DIY Wireless Audio Streaming

By NICHOLAS VINEN

Our CLASSiC DAC (February-May 2013) has a USB socket and can be connected to a PC, so you can play audio files on the computer through a hifi system with top-notch sound quality. But what if your hifi system isn't in the same room as your computer? The answer is that you can use a small and cheap router to wirelessly stream audio between rooms. Here's how.

A FEW MONTHS AGO, we showed how to program a tiny, cheap router with some open source software so that it can act as a web server, control relays and do various other things ("Hacking a Mini Wireless Web Server", November and December 2012). In this article, we will take a similar approach, configuring a slightly different router to stream CD-quality audio over WiFi to a USB audio device such as our CLASSiC DAC.

There are several reasons why you would want to do this. First, if you're listening to music with a reasonable dynamic range, you don't want a computer with a fan or fans running in the same room; you will hear them during the quieter passages.

Second, it's much more convenient to select files to play from a hard disk than it is to dig through a collection of CDs, DVDs or other discs to find the one you want to play. And if you've bought music from iTunes or a similar service, you may not have physical media at all. In fact, just about anything you can play on your PC can be streamed to a remote sound system.

If you have multiple computers in your home, they can be set up so that any one of them can stream audio to the hifi system using this approach. By the way, the unit we describe here is also suitable for streaming audio over wired Ethernet networks, if you already have the wiring and sockets in place.

Commercial options

There are products you can buy to do this job but they are generally not cheap and often have integrated amplifiers and speakers with mediocre sound quality. The aim of this article is to describe how to build your own network streaming solution and get the best possible audio quality but there are off-the-shelf solutions which will do the job too.

If you would prefer to buy a commercial network audio player, one option is to get one with a digital output (TOSLINK or S/PDIF) and then you can connect it to the CLASSiC DAC to ensure the best sound quality.

For Apple users, the easiest solution is to get a set of wireless speakers supporting the "Airplay" protocol.

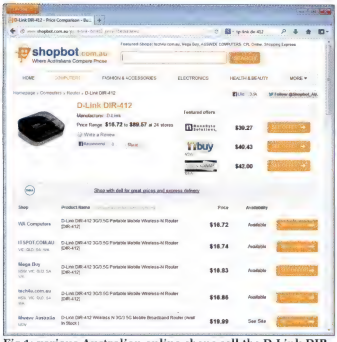


Fig.1: various Australian online shops sell the D-Link DIR-412 router for less than $20. These are also available from overseas sellers via ebay or similar sites.

Other options (with varying operating system support) include the Logitech Squeezebox, Netgear MP101, Marantz NA7004 with external Ethernet/WiFi bridge and the Sonos product range.

Many of these cost over $200 though and while they will generally have more features than what we are describing here, we spent less than $20 on our router. In making that comparison, we're assuming you've already built the CLASSiC DAC.

Wireless performance

To stream CD quality audio, you need a network link with a throughput of at least 1.5Mbps and it has to be pretty reliable – if the connection is dropping in and out regularly, the audio will break up. Modern WiFi products advertise speeds of 54Mbps, 108Mbps, 150Mbps and more. So it would seem like this is a lay-down misère.

But there are various reasons why WiFi performance often falls well short of the advertised speeds and in some situations, it may be difficult to achieve the required speed. The two main reasons are spectrum congestion (ie, interference) and obstacles in the path of the microwaves.

Congestion will depend on how many other people with WiFi networks and 2.4GHz cordless phones live in close proximity to you. If you are in a large apartment block or dense urban area, you will likely find dozens of WiFi networks when scanning with your computer. In this case, you should check that you can reach the required speed (eg, by copying a file to a laptop near your hifi system) before going ahead. 1.5Mbps is equivalent to roughly 200KB/s.

If you are near a lot of WiFi networks, you may be able to improve the speed and reliability of the connection by changing the channel(s) your WiFi router operates on, to one of the less occupied channels. Changing the position of its external antenna(s) (if present) may also help.

If buying a cordless telephone to use in a home with a WiFi network, it's best to pick one that doesn't operate at

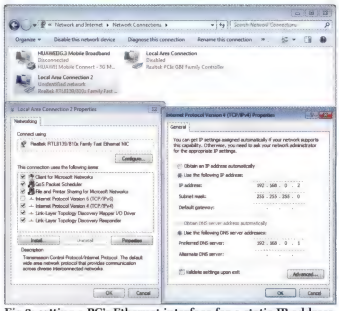
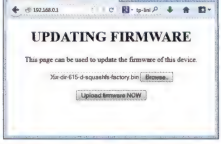


Fig.2: setting a PC's Ethernet interface for a static IP address in Windows 7. Change it back once you are finished.

Fig.3: the DIR-412's recovery page, accessed by holding in the reset button at power-up, lets you re-flash the unit via this web interface.



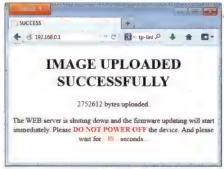


Fig.4: after uploading a new image to the device, it takes about 90 seconds to reconfigure and reboot before you can connect to it.

2.4GHz. But note that WiFi networks can also operate at 5.17-5.825GHz (802.11a/n) so a 5.8GHz cordless phone isn't necessarily the answer either!

As for obstacles, walls and furniture are the most common and there isn't much you can do about that but if the connection is marginal, you may find that slight changes in the position and orientation of the router(s) will make the difference. This is likely due to a combination of the antenna design (these days, often fractal) and standing waves caused by reflections off walls and other internal obstacles. Elevating the router may help, too.

We tested streaming in two environments. The first was in a small office building with two other WiFi signals in range, with the main router inside a steel rack cabinet (near the top). The distance was about 10m with one plasterboard wall in the way. In this case, we got a reliable and

Fig.5: once OpenWRT has been loaded on the router, the next step is to set a root password via its web interface.

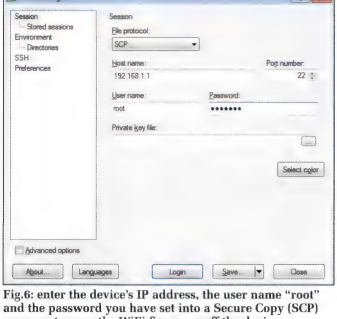


Fig.6: enter the device's IP address, the user name "root" and the password you have set into a Secure Copy (SCP) program to copy the WiFi firmware off the device.

consistent connection of around 20Mbps, giving flawless audio streaming.

The second environment was a medium-sized apartment building with about 10 WiFi networks in range and a brick wall between the two routers. The main router used was an older model with a single external antenna and was placed on a desk. In this case, speed was not an issue but we had to play with the position of the receiving unit to get a reliable connection with no drop-outs.

Our approach

We first tried setting up audio streaming via the TP-Link WR-703N that we featured in our earlier articles on router "hacking". It did work but not reliably. With this unit, when WiFi is enabled, USB audio has intermittent clicks and pops, suggesting USB data packet corruption. That rules that unit out for wireless streaming although it's fine for transmitting audio over Ethernet as long as you disable its WiFi altogether.

As a result, we bought a D-Link DIR-412 instead, in the hope that its slightly different hardware would not have the same bug. Getting it up and running is a bit more difficult since it isn't as popular as the WR-703N and thus OpenWrt has no official support for it. But we did eventually get it working and were relieved to find its audio output is clean, even when streaming over WiFi.

The steps required to set up a DIR-412 for WiFi audio streaming are listed below. This unit is available from local and overseas retailers at a similar price to the WR-703N. At the time of writing, it was available from five different Australian online retailers for less than $20 (not including postage) – see Fig.1.

One of the great things about the DIR-412 is that it has a reset button which can be used to activate an emergency recovery mode, allowing you to re-flash it even if you have accidentally "bricked" it.

In theory, any wireless router with USB ports and OpenWrt support can be used for this project – see http://wiki.openwrt.org/toh/start But the DIR-412 is the model that we know will work so we're going to stick with it.

Problems with OpenWrt

Some readers who re-flashed a router using the steps outlined in our previous articles (mentioned earlier) ran into problems. We believe these are sorted out now. Check the panel later in this article for details on what went wrong and for the solutions.

Preparing the router

Here are the steps to set up the DIR-412 for wireless audio streaming.

(1) Download the two required OpenWrt images. These are available from http://downloads.openwrt.org/attitude_adjustment/12.09/ramips/rt305x/ and have the following file names:

openwrt-ramips-rt305x-dir-615-d-squashfs-factory.bin
openwrt-ramips-rt305x-wr512-3gn-4M-squashfs-sysupgrade.bin

(2) Connect power to the DIR-412 while holding down the recessed reset button at the rear, eg, with a paper clip. Release it after about 10 seconds and the power LED should be flashing orange.

(3) Temporarily disconnect your LAN cable (if present) and connect the DIR-412's Ethernet port to your PC; you can use the supplied cable.

(4) Set your computer to use a static IP address of 192.168.0.2. In Windows 7, this can be done by going to the Network and Sharing Centre (accessible via the Control Panel), clicking "Change adapter settings", double clicking your Ethernet adaptor, clicking Properties, then double-clicking on the TCP/IPv4 entry – see Fig.2.

Select "Use the following IP address" and enter 192.168.0.2 with a subnet mask of 255.255.255.0, then click "OK" several times to close the remaining dialogs. Other versions of Windows use a similar procedure.

(5) Point a web browser to http://192.168.0.1 (ie, type that in the address bar) and you should get a screen like Fig.3.

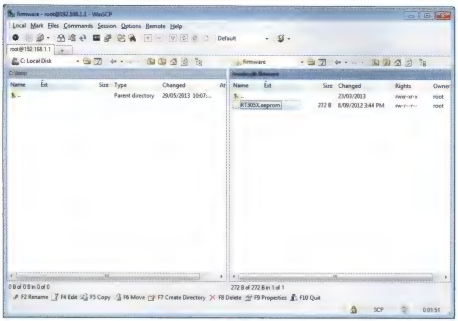


Fig.7: after connecting to the DIR-412 using WinSCP, navigate to the firmware directory (at right) and copy the *RT305X.eeprom* file to a temporary location on your PC (left). This is necessary as there is no official OpenWRT image available for the DIR-412 and doing so allows us to get USB and WiFi both working at the same time.

If not, check that the DIR-412 is in emergency recovery mode (ie, flashing orange power LED) and check that the IP is set correctly (eg, run "ipconfig" in a command prompt) and the Ethernet cable is plugged in correctly at both ends.

(6) Click the "Select" button and then browse to the first file you downloaded earlier, for the DIR-615 router.

(7) Click the "Proceed" button and you should then get a screen similar to Fig.4. Don't touch any of the cables to the DIR-412 during the 90-second countdown as the unit is re-flashed.

(8) Change your computer's IP address to 192.168.1.2 using the same procedure as in step 4.

(9) Point your browser at **http://192.168.1.1** and you should get the LuCI login screen (Fig.5). Click the "login" button.

(10) Click the link at the top of the screen to set a password, then enter your chosen password in both boxes and click the "Save & Apply" button in the bottom corner.

(11) Use an SCP program such as WinSCP to log into the router with the user name "root", your chosen password and an IP address of 192.168.1.1 (Fig.6). When you get a warning about the server's host key not being found, click "Yes" to proceed. You may also get a message "Error getting name of current remote directory"; click OK to ignore it.

Copy the file **/overlay/lib/firmware/RT305X.eeprom** to your PC. To find this, you may need to double-click the ".." entry first – see Fig.7.

(12) Go back to the web interface, click the "System" tab at the top, then the "Backup / Flash Firmware" tab that appears below it. Near the bottom of the screen, under "Flash new firmware image", click on the Browse button and choose the second OpenWrt file you downloaded, for the WR512-3GN router (Fig.8). Click the "Flash Image" button and it will verify that the file is valid (Fig.9); click the button to proceed with re-flashing.

(13) Wait about 90 seconds and the web interface should automatically re-load; if not, re-enter **http://192.168.1.1** in your browser address bar. You will need to log back in.

(14) Use SCP to copy the **RT305X.eeprom** file back onto the re-flashed router, over the top of the file in **/overlay/lib/firmware**. If asked whether to overwrite the existing file, select "Yes".

(15) Go to the System tab on the web interface, then click on the Reboot sub-tab under it at right and then click the "Perform reboot" link.

(16) Once it has rebooted, log back into the web interface. Click on the Network tab, then the WiFi sub-tab. Enable WiFi using the button labelled as such and the wireless LED on the router should turn green. Click "Scan". You should get a list of nearby wireless networks (Fig.10).

Click the appropriate "Join Network" button and enter the password and other details required to access your network. Select the "lan" firewall zone (green), click the "Submit" button and then "Save & Apply" at the bottom.

(17) Wait about 20 seconds, then click on the Interfaces sub-tab near the top of the screen and check that "WWAN" is shown with a green background. If you have DHCP on your network (most people do), the unit should have picked up an IP address which will be shown to the right, under IPv4 and it will normally start with "192.168". Make a note of this IP. Also go to the "Status" tab and write down the Netmask, Gateway and DNS addresses under "Network".

(18) Under Interfaces, click on the button to edit this WWAN interface (at right) and then change "DHCP client" to "Static address". Click "Switch protocol", and in the "IPv4 address" box which appears, enter the address you want to assign to the router. It should be the same as the address you noted in the last step except for the final number.

You need to choose this number carefully so that it can't conflict with another device which has its IP address allocated automatically by the main router via DHCP. That

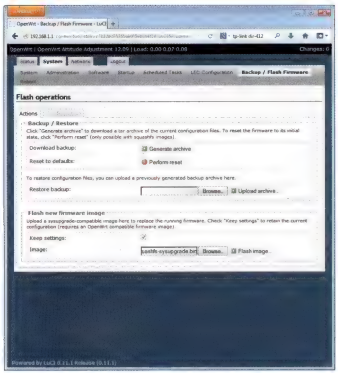


Fig.8: use the Flash operations tab to replace the current firmware image with one that has USB support.

router will assign DHCP addresses with a range of numbers, typically ending in a number between 10 and 100. Higher numbers are generally safe, eg, between 200 and 250. If in doubt, check your main router configuration.

Also enter the Netmask, Gateway and DNS addresses that you noted earlier, then save and apply the changes.

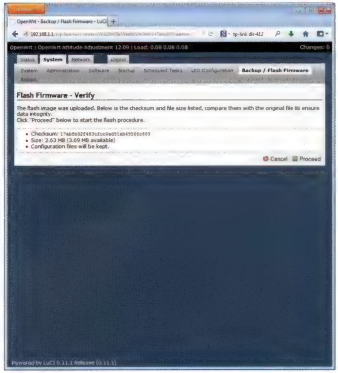


Fig.9: after uploading the new image, you're asked to verify that it is correct and you want to proceed. If you use the file we specified, your checksum should match ours.

(19a) Click on the Interface sub-tab again. What you do next depends on whether you will be connecting the router to Ethernet or just using wireless.

(19b) Wireless only: compare the IPv4 addresses for LAN and WWAN. If they have the same first three digits (eg, both start with 192.168.1) then you will need to change the LAN IP address or else wireless will not work with the Ethernet cable unplugged.

Click on the Edit button to the right of the LAN interface, change the second-last digit in its address, then click the Save & Apply button. Make a note of this new address since if you lose access to the wireless network, you will need to use this address to access the router; if all else fails, you can always use the emergency recovery mode.

(19c) Wired and wireless: pick another address similar to what you assigned to the wireless interface but not the same (eg, 192.168.0.201) and assign this to the LAN interface, using a similar procedure as in step 19b. Note that in this case, if the unit is not connected to an Ethernet network, the WiFi interface will be inoperative.

(20) Unplug the Ethernet cable from the D-Link DIR-412 router and your PC, then re-connect your PC to its usual network (if a cable was plugged in before). If you will be using the DIR-412 with a wired connection, connect the Ethernet cable.

(21) On your PC, point a browser at the IP address you have assigned to the wireless network of the DIR-412, eg, **http://192.168.0.200** You should then be able to log into the web interface as before. This confirms that the wireless interface is working properly.

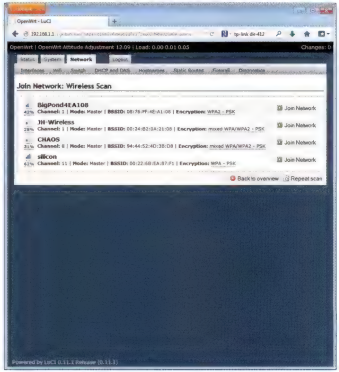


Fig.10: once the new WiFi firmware is in place, you can perform a Wireless Scan and then find and connect to your WiFi network.

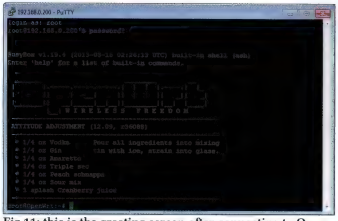


Fig.11: this is the greeting screen after connecting to OpenWRT with a Secure Shell (SSH) program. You can then install extra software and set it up using text commands.

(22) Use an SSH program such as PuTTY (Windows) or OpenSSH (Linux/Mac) to login as root at this same IP address, using the same password as for the LuCI web interface. Again, we described how to do this in the November 2012 issue but if you install and run PuTTY, it should be pretty easy to figure out. You should then get a text greeting screen as shown in Fig.11.

(23) Type the command "opkg update" and press enter. It will then download the list of available packages from the internet with the message "Updated list of available packages ...". If you get an error message instead, that suggests the gateway and/or DNS addresses entered earlier are wrong; correct them via the web interface and try again.

(24) Once this list has updated, type **opkg install netcat kmod-usb-audio** and press enter. This installs the USB audio driver and a program to stream data over a TCP/IP network.

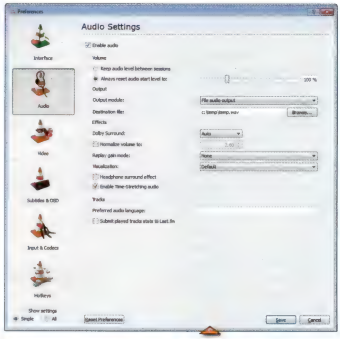
(25) To check that USB audio is working, plug the CLASS-iC DAC or a USB audio dongle into the port on the top of the router and then type **cat /proc/asound/cards**. You should get a result something like this:

```
0 [CODEC    ]: USB-Audio - USB Audio CODEC
Burr-Brown from TI USB Audio CODEC at usb-dwc_otg.0-1, full speed
```

(26) Now for the audio playback software. This comes in packages with other software we don't want and which won't fit in flash. So we install them to a temporary location in RAM and then copy just the required files into flash.

To do this, type **opkg install -d ram alsa-utils** and press Enter. Several packages will be downloaded and installed. Then, type the following series of commands:

```
cp /tmp/lib/libpthread-0.9.33.2.so /tmp/lib/librt-0.9.33.2.so /lib
cd /lib
ln -s libpthread-0.9.33.2.so libpthread.so.0
ln -s librt-0.9.33.2.so librt.so.0
cp /tmp/usr/lib/libasound.so.2.0.0 /usr/lib
cd /usr/lib
ln -s libasound.so.2.0.0 libasound.so.2
cp /tmp/usr/bin/aplay /usr/bin
cp -R /tmp/usr/share/alsa /usr/share
```



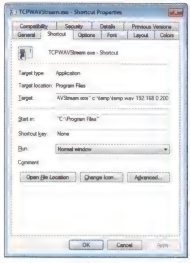


Fig.12 (above): VLC is a media player that's available for multiple operating systems, including Windows. It can play audio to a file on disk which we then stream over the wireless network.

Fig.13 (left): a shortcut like this can then be used to launch the software and start streaming audio at any time.

Check that it is installed correctly by typing **aplay -h** – you should get a long help text. Otherwise, one of the above files may not have been copied correctly.

(27) By default, audio played will be resampled to 48kHz. But if you are mostly playing music from CDs, then these will be 44.1kHz so to get the best audio quality, we want to change this default rate. This can be done with the following command: **sed -i s/48000/44100/ /usr/share/alsa/alsa.conf**

Confirm this worked by running **grep 44100 /usr/share/alsa/alsa.conf** and you should see: **defaults.pcm.dmix.rate 44100**

(28) We are now ready to set up the streaming audio receiver. This can be done with the following command (be careful to type it exactly and only press enter at the end): **echo 'while [1]; do netcat -l -p 44100 | aplay -B 100000 -r 44100 -c 2 -f S16_LE -t raw -; done &' > /etc/rc.local**

Then to get it going, make sure the USB audio device is plugged in and then type this command: **source /etc/rc.local** This will happen automatically each time it boots from now on.

Problems With The WR-703N Router & OpenWRT

WE GOT AN enthusiastic response to our articles on re-flashing the WR703N mini router ("Hacking A Mini Wireless Web Server", November & December 2012). Unfortunately though, some readers who purchased a WR703N and attempted to re-flash it ran into problems. There were two different reasons for this.

The first is that late last year, the manufacturers of the WR703N brought out a new version of the device (v1.7) that worked a bit differently from the previous version. Specifically, its bootloader software disables the Ethernet port on boot and relies on the main program to re-enable it, something that was not necessary with earlier versions of the device. Note that many of the affected devices have a sticker on the bottom incorrectly showing the version as 1.6.

The OpenWRT software has since been patched to fix this (ie, enable Ethernet on boot), so if you buy one of these routers now and attempt to flash it, it should work. But those people who flashed their units before this fix was released (right at the end of 2012/beginning of 2013) were left unable to connect to it via either Ethernet, which was disabled, or WiFi, which needs to be set up before it can be used.

In this case, the only solution is to solder a serial port connector to three small pads on the PCB, as shown here: **http://forums.openpilot.org/blog/52/entry-92-unbrick-wr703n-wifi-router/** You can then change settings or re-flash the unit via a serial console, as described on that web page. More information on the Ethernet boot problem can be found at **https://forum.openwrt.org/viewtopic.php?id=40986**

New versions of OpenWRT

Another problem that some readers encountered was that they were unable to install certain packages using the **opkg** program, mainly those starting with **kmod**. The problem is that OpenWRT was a work in progress last year when we published the articles describing how to re-flash the WR703N. After you had re-flashed your unit, there was the possibility that changes to the software on the OpenWRT website would render the available packages incompatible with the now out-of-date version of the firmware on your router.

In fact, the version of the software that we recommended using, **Attitude Adjustment**, has now been finalised with version 12.09 and they have started work on a new version called **Barrier Breaker**. Because we recommended installing OpenWRT from the "trunk" repository, that means that when they switched over from **Attitude Adjustment** to **Barrier Breaker**, it became virtually impossible to install kernel module packages as it would try to download files for the wrong version.

If you have this problem, you have two options: either re-flash your router with the latest version of **Attitude Adjustment** or move over to **Barrier Breaker**. In general, we recommend sticking with the former solution as it means you are far less likely to run into this same module compatibility problem in future although **Barrier Breaker** has some new features which some people may wish to experiment with. Either way, the procedure is similar. For **Attitude Adjustment**, download the latest sysupgrade firmware from this location:

http://downloads.openwrt.org/attitude_adjustment/12.09/ar71xx/generic/openwrt-ar71xx-generic-tl-wr703n-v1-squashfs-sysupgrade.bin

For ***Barrier Breaker***, it can be found here:

http://downloads.openwrt.org/snapshots/trunk/ar71xx/openwrt-ar71xx-generic-tl-wr703n-v1-squashfs-sysupgrade.bin

Use the procedure described in this article (step 12) to re-flash the router with this new firmware. Note that you may need to re-install any packages you installed previously with **opkg** after doing this.

Note also that you may already have **Barrier Breaker** if you used the instructions we published previously after the trunk had been switched over. And if you do, some of the packages that we explained you should install in those articles may not be necessary. For example, **kmod-usb-storage** may already be present and not required to access a USB flash drive that's plugged into the router.

The DIR-412 is now ready to receive audio. Check that the USB audio device is plugged into it and move on to setting up your PC.

Streaming to it

To send audio to the unit, it's simply a matter of making a TCP connection on port 44,100 and sending a WAV file containing the PCM audio data.

That sounds easy but we couldn't easily find Windows music players with this sort of capability so we've come up with a small program which allows you do this. It's called "TCPWAVStream" and we are making the source code and Windows executable file available for download. It also builds and runs on Linux (make sure **gcc** and **binutils** are installed, then run **make**). It will probably work in Mac OSX too, since that is based on BSD. However, we haven't actually tried to compile it on a Mac.

This software can work in one of two ways. The simplest is to use a music/video player such as VLC. You can download the Windows version for free from **http://www.videolan.org/vlc/download-windows.html**

Once VLC is installed, you then set it up to output sound to a WAV file. To do this, go to **Tools -> Preferences -> Audio** and then change the Output module to "File audio output". Select a destination file on a drive with plenty of free space. We set ours to **c:\temp\temp.wav** (see Fig.12; the directory **c:\temp** must exist). You will then need to re-start VLC for this to take effect.

Download and unzip **TCPWAVStream.exe** and **cygwin1.dll** to a convenient location (eg, **C:\Program Files**), then create a shortcut to the exe file on your desktop, or wherever you prefer. Right-click on this shortcut, then select "Properties" and change the Target field to add a space at the end, then the name of your WAV file in quotes, then another space and then the IP address of the router to stream to.

In our case, the Target field then contains (see Fig.13): **"C:\Program Files\TCPWAVStream.exe" "c:\temp\temp.wav" 192.168.0.200**

Double-click this shortcut and it should open a text box. Now play a file in VLC and you should see the buffer fill up, as indicated by an increasing buffer percentage (Fig.14). Once the buffer reaches about 70% full, assuming your router is switched on and ready, the program will open a connection and start streaming audio to it.

When this happens, the buffer percentage should drop to about 50% and hover around that. Meanwhile, the lights on the router will flash to indicate constant data reception and audio playback should begin. Confirm this by listening to the DAC's output. To stream audio in future, assuming the wireless router is powered on, you just need to launch that shortcut and then play the file(s) in VLC.

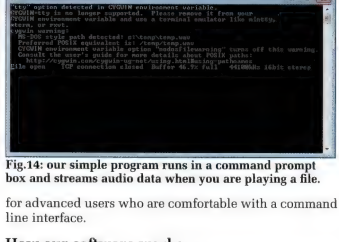


Fig.14: our simple program runs in a command prompt box and streams audio data when you are playing a file.

Another option

If you want to use other audio software which doesn't have a WAV writer feature, there is another option. Download and install the latest version of the "Virtual Audio Capture Grabber Device" from http://sourceforge.net/projects/virtualaudiodev/files/

This software essentially allows you to record whatever is being played from your PC, ie, it is a loopback device. You can then feed this recorded audio to our streaming software. Then anything you play on your PC will also be sent to the router and thus to your hifi system. We don't know for sure whether this is a purely digital path or whether noise and distortion can be introduced by this process but it sounds reasonably clean.

Once you have installed the device, you can then create a shortcut to start up the streaming. Navigate to the directory where is has installed ***ffmpeg.exe***. In our case, this is the following rather long path:

C:\Program Files (x86)\Virtual Audio Capture Grabber\screen-capture-recorder-to-video-windows-free\configuration_setup_utility\vendor\ffmpeg\bin

You will then need to create a batch file (eg, **TCPWAVStream.bat**) to initiate streaming. This should contain the following, which you will need to adjust depending on where your **ffmpeg.exe** and **TCPWAVStream.exe** files are located:

cd "C:\Program Files (x86)\Virtual Audio Capture Grabber\screen-capture-recorder-to-video-windows-free\configuration_setup_utility\vendor\ffmpeg\bin"
ffmpeg -f dshow -i audio=virtual-audio-capturer -acodec pcm_s16le -f wav -loglevel panic - | "c:\Program Files\TCPWAVStream.exe" - 192.168.0.200

You can do this by typing those lines into notepad (note: just two lines, one starting with "cd" and one with "ffmpeg") and then saving it as a file with a .bat (batch file) extension.

Run this .bat file and you should get a result similar to that described above although since this will be constantly capturing audio whether or not you are playing anything, it should begin buffering immediately.

Direct streaming

You can also use **ffmpeg** to decode and stream audio files direct to the router without going through your system's sound card or a temporary file but you will need to use the command line to play back files. All you need to do is use the **ffmpeg** command above but get rid of the **-f dshow** and **-i audio=virtual-audio-capturer** parameters and replace them with the name and path of the file to be played.

This works in Linux too but is really only appropriate for advanced users who are comfortable with a command line interface.

How our software works

While the **TCPWAVStream** program is rather elegant in its operation (we think), it is still rather complex and we won't go into great detail here – if you're interested, have a look at the source code. But in brief, what it does is constantly read from the end of the file specified (or standard input) into a circular memory buffer while also emptying that buffer to a TCP "socket" which sends the data to the router.

The WAV header contains the audio format details (sampling rate, etc) and the router thus configures its audio output to match that of your PC. Because the router only consumes the data from its socket at its internal sampling rate, this effectively throttles the emptying of the buffer.

While the sampling rate of the playback from your PC will in theory match that of the audio device attached to the router, in practice they will never be exactly the same as they are using different crystals to derive the sampling rate. This means that the memory buffer in the PC software will slowly fill or empty over time. The software attempts to keep the fill to about 50% by slightly shortening or lengthening any periods of silence in the data it streams.

The software gracefully handles situations such as the WAV file being deleted or truncated (which is what happens when VLC starts playing a different file), the connection to the router being dropped or the router being temporarily unreachable and so on. Note that it will delete the WAV file once it has finished reading it, if it remains unchanged for a short period, so you should only point it at temporary files.

Also note that because there are multiple layers of buffering – ie, in VLC/Virtual Audio Grabber, the file system, the TCPWAVStream software, the network buffers on both ends, in the audio player on the router, its USB hardware and in the USB device itself – there will be quite a delay between starting or stopping playback and a change actually occurring at the output. This will be of the order of a couple of seconds.

This isn't normally a problem when playing music but if you want to stream the audio from a video, you will need to change the A/V synchronisation delay or else the audio and video will not match up. With VLC, this can be done using the "j" and "k" keys on your keyboard. Other video playback software may or may not have this capability.

If you experience audio dropouts in the audio while streaming, the likely cause is an unreliable WiFi link. Refer to the section on wireless performance for information on likely methods to correct this. SC

Into model railways?
Then you'll want to build the . . .

Li'l Pulser Model Train Controller, Mk.2

By JOHN CLARKE

This project started out as a simple revision to our very popular Li'l Pulser train controller featured in the February 2001 issue. But while it fits into the same tiny case of the original design, this new controller has a lot more features and it can deliver four times as much current. It's become the "Li'l Pulser that could!"

UNLESS YOU ARE already using a previously published SILICON CHIP model train controller, this little feature-packed controller is likely to be better than any controller you have used. This is particularly true if you are using a commercially-made low-cost rheostat or series transistor train controller.

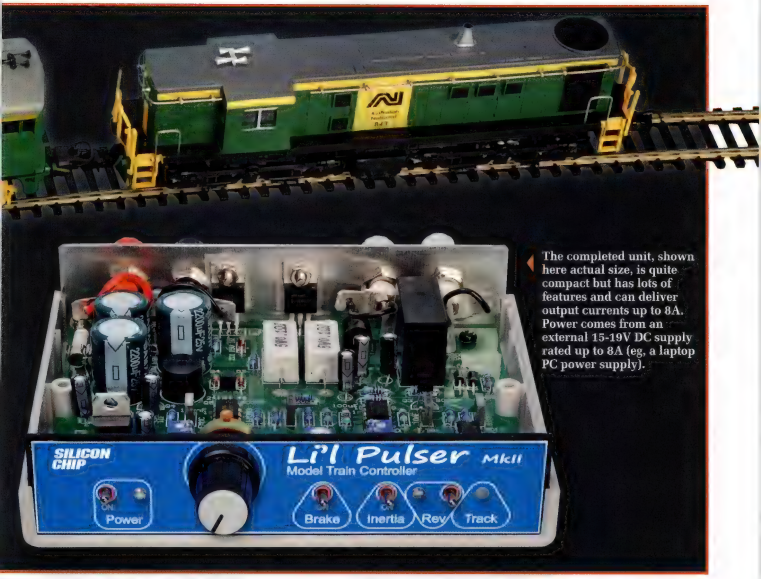
Simple train controllers have plenty of shortcomings. To get the loco started, you have to wind the speed control way past the setting at which you would want it to run. Then the loco suddenly takes off like a startled rabbit. Once running, with reduced throttle setting, the loco then slows down whenever there is the slightest incline.

So what makes Li'l Pulser so much better? Well, firstly it will control the loco at the speed you want, with smooth starts and not too much speed reduction on hills. In model railway jargon, "pulse power" is what makes this little train controller such a good performer.

Don't let the small case fool you. This little train controller has just about all the operational features of our best designs (such as the Railpower IV from September & October 2008). And there is no heavy mains transformer or mains wiring involved because you can use an original train controller supply, a 12V lead-acid battery charger or any 15-19V switchmode laptop PC power supply rated at up to 8A.

Pulse power

As noted earlier, our Li'l Pulser applies pulse power to the railway track.



The completed unit, shown here actual size, is quite compact but has lots of features and can deliver output currents up to 8A. Power comes from an external 15-19V DC supply rated up to 8A (eg, a laptop PC power supply).

This involves applying 17V voltage pulses (typically) to the track, even at low throttle settings. These voltage pulses are much more effective at starting and running a loco, particularly at low settings.

The pulses overcome track resistance and motor and gearbox stiction, thus providing a smooth-running loco motor. At low speeds, the 17V pulses are very short so that the average voltage is low and the motor runs at a slow speed. For faster operation, the pulses are wider, thus applying a higher average voltage to the motor.

But pulse power is not the only feature of this latest Li'l Pulser model train controller. It also includes monitoring of the motor back-EMF to provide very good speed regulation. Without this back-EMF control, the model locos would slow down unrealistically with any slight incline.

Naturally, Li'l Pulser Mk.2 has reverse polarity and overload protection (essential features for any but the simplest model train controller), together with an audible alarm which beeps briefly for momentary track shorts but which sounds for longer for more severe overloads.

New features

The original Li'l Pulser had very basic features: a speed control potentiometer, three LEDs to indicate power on, reverse and track voltage, and a switch for forward/reverse operation.

By contrast, Li'l Pulser Mk.2 has several added features that vastly improve the realism of operation, including inertia (sometimes called "momentum"), braking and reverse lockout, plus minimum and maximum speed settings.

The most useful added feature is

Main Features

- Pulse power for smooth running
- Excellent low speed control
- Speed regulation
- Speed control pot
- Inertia and braking simulation
- Minimum and maximum speed adjustments
- Adjustable inertia and braking rates
- Inertia on and off selection
- Power on indication
- Track voltage LED indication
- Reverse indicator
- Over-current/short circuit alarm
- Compact size
- Maximum current: 8A
- Power supply: 15-19V DC

Li'l Pulser Parts List

1 double-sided PCB, code 09107131, 129.5 x 100.5mm
1 front panel PCB, code 09107132, 132 x 30mm
1 rear panel PCB, code 09107133, 132 x 30mm OR
1 aluminium rear panel, 134 x 30 x 1mm (see text)
1 plastic instrument case, 140 x 110 x 35mm (Jaycar HB-5970, Altronics H 0472)
1 piezo buzzer (Jaycar AB-3459, Altronics S6104)
1 16mm 10kΩ linear PCB-mount potentiometer (VR1)
1 1MΩ miniature horizontal-mount trimpot (VR4)
1 250kΩ miniature horizontal-mount trimpot (VR5)
3 10kΩ miniature horizontal-mount trimpots (VR2,VR3,VR6)
1 1kΩ miniature horizontal-mount trimpot (VR7)
2 nuts and washer for VR1
1 19mm knob to suit potentiometer
1 8A DPDT PCB mount relay (Altronics S 4190D) (RELAY1)
4 SPDT PCB mount toggle switches (Altronics S 1421) (S1-S4)
1 2.5mm PC mount DC socket
1 black binding post
1 red binding post
2 white binding posts
4 6.3mm 45° chassis-mount spade terminals (Jaycar PT-4900, Altronics H 2251)
1 8A M205 fuse (F1)
2 M205 fuse clips
2 TO-220 insulating bushes
2 TO-220 silicone insulating washers
4 M3 x 5mm screws
2 M3 x 10mm screws
2 M3 nuts
7 PC stakes
1 200mm length of 8A hook-up wire

Semiconductors

1 LM358 dual op amp (IC1)
1 LM324 quad op amp (IC2)
1 LM393 dual comparator (IC3)
1 4013 dual D-flipflop (IC4)
2 IRF1405 55V 169A Mosfets (Q1,Q2)
2 BC337 NPN transistors (Q3,Q5)
1 BC327 PNP transistor (Q4)
1 7812 3-terminal 12V regulator (REG1)
1 15V 1W zener diode (ZD1)
1 FR607 6A diode (D6)
2 1N4004 1A diodes (D1,D5)
4 1N4148 switching diodes (D2-D4, D7)
1 3mm 2-lead bi-colour LED (LED1)
1 3mm red LED (LED2)
1 3mm green LED (LED3)

Capacitors

3 2200μF 25V low-ESR electrolytic (22mm high or less; eg, element14 1800659)
4 100μF 16V PC electrolytic
1 47μF 16V low-leakage PC electrolytic or tantalum
1 10μF 16V PC electrolytic
2 1μF 16V PC electrolytic
1 1μF monolithic ceramic (MMC)
1 220nF MKT polyester
2 100nF MKT polyester
1 22nF MKT polyester
1 10nF MKT polyester

Resistors (1%, 0.25W)

1 1MΩ	5 4.7kΩ
1 470kΩ	3 2.2kΩ
1 220kΩ	2 1kΩ
5 100kΩ	2 470Ω
2 47kΩ	1 10Ω
9 10kΩ	2 0.1Ω 5W 5%

reverse lockout. This makes it impossible to throw the loco into reverse while it is moving in the forward direction. This is highly desirable, for two reasons. Firstly, it is more realistic and secondly it prevents derailments. Reverse lockout means that even if you inadvertently switch to change the direction of the train while it is moving, the controller won't do anything until the train has come almost to a full stop.

Inertia and braking add realism to loco operation. While you can simulate the slow increase in speed during starting and the slow decrease in speed during braking by careful adjustment of the speed control, the inertia and braking functions do it automatically and consistently.

It means that the throttle can be preset and the starting and stopping done entirely using the inertia and braking functions. The brake typically slows down the loco at a faster rate than the start-up inertia rate. There are trimpots on the PCB to set these rates.

But while simulated inertia is good most of the time, it can be a problem for shunting operations. So we've added a front panel switch to disable inertia when you don't need it.

Locos don't buzz when stopped

In case you are wondering, the Li'l Pulser does not cause locos to buzz when they are stopped. All model locomotives require a few volts DC before they will start moving and before that, pulse power will cause them to buzz. However, the minimum speed setting in the Li'l Pulser can be set to switch off the pulses whenever the loco is stopped.

And as we implied above, the Mk.2 version of Li'l Pulser is muscle-bound compared to the original Li'l Pulser because it can now deliver up to 8A DC. This means that it can easily handle trains with double-headed locos, even if they have smoke generators, sound and lighting.

This improvement is mainly due to a vastly better Mosfet than that used in the original design.

With all these added features, the controller is still mounted in the same compact plastic case, measuring just 140mm wide, 35mm high and 110m deep. We have packed all the circuit features onto a double-sided PCB with plated-through holes.

On the front panel, there are toggle switches for power, inertia, braking and forward/reverse switching. There is one knob for the throttle control and the three LEDs. The track LED is bi-coloured: green for forward and red for reverse. The reverse LED is red, to give an indication when a train is set to go backwards.

There are four binding post terminals on the rear panel, two for the input power and two for the leads to the track. A DC socket is also included for power but be aware that these DC sockets are not rated for much above about 4A. So use the binding posts for higher current operation.

Pulse width modulation

Before having a look at the full circuit of the Li'l Pulser, we should describe how the circuit generates the varying width pulses which drive the loco motor. To do that, we have taken the core of the circuit, as shown in Fig.1. It basically consists of a ramp (triangle) wave generator based on IC1a and a comparator based on IC3b.

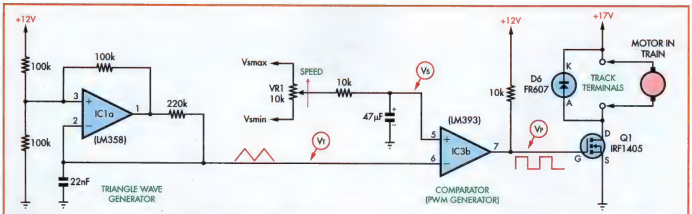


Fig.1: the core of the circuit. IC1a generates a triangle waveform and this is compared with the output voltage from the speed pot (VR1) in comparator IC3b to produce a 160Hz pulse waveform. This then drives Mosfet Q1 which switches the supply voltage to the tracks each time it turns on.

The IC numbers correspond to the same parts on the main circuit shown in Fig.3.

IC1a is one half of an LM358 dual op amp and is configured to work as an oscillator running at about 160Hz. It works by charging and discharging a 22nF capacitor at its inverting input. The result is a triangle (ramp) waveform at pin 2 and a square wave at its output, pin 1. The triangle waveform is fed to the inverting input (pin 6) of IC1b, one half of an LM393 dual comparator.

The comparator compares the triangle wave at pin 6 with the DC voltage from VR1, the speed control potentiometer. This is depicted in the waveforms shown in Fig.2, with the DC voltage from VR1 shown as the horizontal line V_S. Whenever the triangle voltage V_T is below V_S, the output V_P at IC3b's pin 7 will go high. Similarly, when V_T is above V_S, V_P will go low.

The result is a 160Hz pulse waveform which drives the gate of Mosfet Q1, turning it on each time V_P is high. Fig.2(a) shows the result when the speed pot VR1 is set for a high speed while Fig.2(b) shows the result for a low-speed setting.

These waveforms are confirmed by the scope shots accompanying this article.

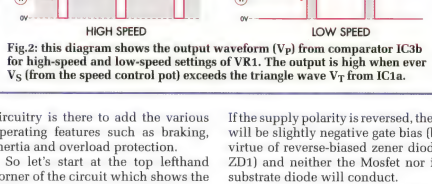


Fig.2: this diagram shows the output waveform (V_P) from comparator IC3b for high-speed and low-speed settings of VR1. The output is high when ever V_S (from the speed control pot) exceeds the triangle wave V_T from IC1a.

Circuit description

Now let's have a look at the full circuit shown in Fig.3. It uses four low-cost ICs, two power Mosfets and a relay for forward/reverse switching. IC1a is on the lefthand side of the diagram, while IC3b and Mosfet Q1 are on the righthand side. Most of the rest of the circuitry is there to add the various operating features such as braking, inertia and overload protection.

So let's start at the top lefthand corner of the circuit which shows the DC input and Mosfet Q2 which has a rather odd configuration. It is actually in series with the negative return lead and we are using it for polarity protection instead of a silicon diode.

It works in two ways. Initially, at switch-on, the Mosfet is off but its substrate diode (between drain and source) conducts to let current flow. Then, once the supply voltage across the three 2200µF input capacitors builds up, the Mosfet's gate is biased on and so the Mosfet turns hard on and conducts with a very low forward voltage of only a few tens of millivolts; much lower than even a Schottky diode, since its drain source resistance is only 5.3 milliohms!

Note that the Mosfet conducts even though its drain is negative with respect to its source electrode. If this seems a little puzzling, consider that a Mosfet will conduct in either direction, as long it has the correct gate voltage polarity; in this case, positive.

If the supply polarity is reversed, there will be slightly negative gate bias (by virtue of reverse-biased zener diode, ZD1) and neither the Mosfet nor its substrate diode will conduct.

Because the forward voltage loss across Mosfet Q2 is so low, the amount of power it dissipates at any current up to our rated circuit maximum is very low. In fact, at the rated circuit current of 8A, the power dissipated in Q2 is only around 340mW which means that, strictly speaking, it doesn't need any heatsinking at all.

The same general comment goes for Q1, which is also an IRF1405 automotive Mosfet. And minimum heat means that we can have a high-power circuit sitting in a small plastic case.

Relay rating

Given that the IRF1405 Mosfet is a high-power device, what actually sets our rated circuit current of 8A maximum? The answer is the reversing relay. Its contacts are rated to switch 8A DC. The other determinants of the maximum current are the two 0.1Ω 5W wirewound resistors at Q1's source, as described later this article.

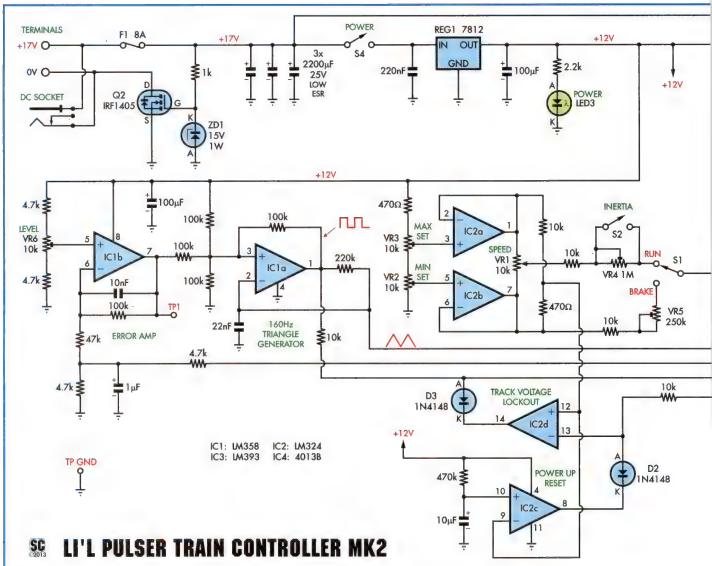


Fig.3: the complete circuit for the Li'l Pulser includes back-EMF monitoring based on error amplifier IC1b, to ensure good speed regulation. Also included are a relay (RELAY1) to provide forward & reverse direction, simulated inertia, overload protection (IC3a) and a lock-out feature to prevent a change of direction until the loco has been brought to a stop.

Going back to the DC input, which can typically be 17V or more, after being fed in via the power switch S4, it then feeds 3-terminal regulator REG1 which provides 12V to all of the circuit except for Q1 which switches the 17V DC rail directly to the tracks.

Speed control

Let's now look at how the basic circuit of Fig.1 has been refined. First, speed control potentiometer VR1 is fed via two op amps, IC2a and IC2b. These are connected as voltage followers, fed by trimpots VR2 and VR3. So VR2 provides the minimum speed setting (minimising the "dead spot" at the low setting of speed potentiometer VR1) and VR3 provides the maximum speed setting, so that you cannot apply more than the maximum rated voltage for the locos you are using. Typically, HO-scale locos run with a maximum of 12V DC and N-scale locos typically run with a maximum of 9V.

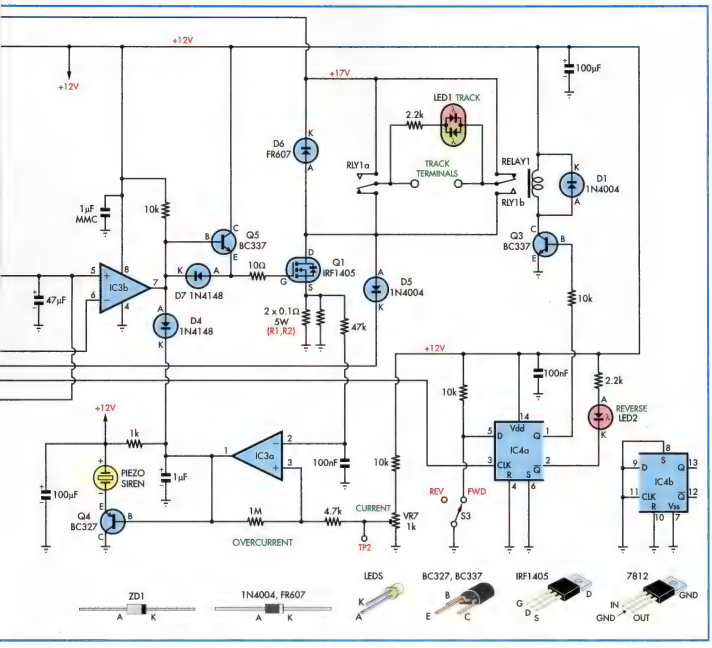
The voltage from the wiper of speed control pot VR1 is fed via trimpot VR4 and switch S1 to the 47µF capacitor at pin 5 of IC3b. This provides the "inertia". What happens is that when you wind up the speed control pot, the actual change in voltage appearing at pin 5 of IC3b is slowed down by the time-constant of VR4 and the 47µF capacitor. Higher settings of VR4 give more inertia, simulating the effect of a heavier train.

For shunting operations, we don't want inertia so it can switched off by S2 which shorts out VR4.

Braking

While inertia is for simulating heavy trains, in the scale world of models, we normally want to stop or slow down trains much more quickly than would be possible (or safe) in the full-scale world. So braking switch S1 is included. It is set to RUN when the loco is being driven normally and then to BRAKE when you need to bring it to a quick stop.

In operation, setting S1 to BRAKE connects VR5 to the 47µF inertia capacitor and this has the effect of discharging the capacitor to the output of IC2b, the minimum speed op amp.



This means that the 47µF capacitor is only discharged to the point where Q1 is just turned off; any more and there would be more than the necessary delay when the brake was removed.

Mosfet switching

In our simplified circuit of Fig.1, we show the output pulses from 1C3b directly driving the gate of Mosfet Q1. However, that is not the most effective way to drive the Mosfet if we want to minimise its power dissipation.

The problem is that Q1 has quite a high gate capacitance and if we just turn it on via IC3b's 10kΩ load resistor (this an "open-collector" output), Q1 would turn on relatively slowly for each positive gate pulse. As a result, its dissipation would be higher than we want, as it would spend more time in partial conduction.

For that reason, the gate drive is via transistor Q5 which is connected as an emitter follower. This pulls up Q1's gate much faster, to minimise switch-on time. Conversely, when IC3b's output goes low, Q1's gate is quickly pulled low via diode D7.

Overload protection

Comparator IC3a provides the overload current protection. Two 0.1Ω 5W resistors connected in parallel monitor the load current (ie, through Q1) and the resulting voltage is fed to IC3a's pin 2 via a 47kΩ resistor. The associated 100nF capacitor provides filtering.

The non-inverting input at pin 3 is connected to trimpot VR7, the current setting control. If the voltage at pin 2 exceeds that at pin 3, IC3a's pin 1 output pulls pin 7 of IC3b low via diode D4. This removes gate drive from Q1.

You then get a "hunt" condition whereby the removal of gate drive to Q1 stops the overload current, so IC3a's output goes high and the Mosfet switches on again. This switching on and off is slowed down using a 1µF capacitor connected to IC3a's output.

IC3a also drives a piezo alarm via transistor Q4 to indicate when an overload is occurring.

Speed regulation

The loco's motor generates a back-

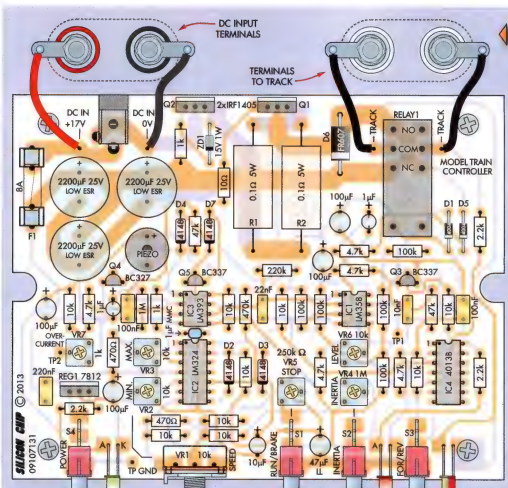


Fig.4: install the parts on the PCB as shown on this layout diagram. Be sure to orientate the ICs, Mosfets, diodes zener diodes and electrolytic capacitors correctly.

Right: the prototype used the plastic front panel supplied with the case, plus a paper label. PCB front panels with pre-drilled holes and screened lettering are available from the SILICON CHIP Online shop.

EMF that is directly proportional to its speed. In other words, during the period that the motor is not driven by the pulses, it acts as a generator, supplying voltage at its output terminals. We use this back-EMF as a feedback signal to make sure that the controller maintains a relatively constant motor speed for a given throttle setting, regardless of variations in load.

In operation, the motor's back-EMF is monitored by D5 which conducts when Mosfet Q1 is off. Note that D5 monitors the negative terminal of the motor and any back-EMF will be negative with respect to the +17V rail. At low motor speeds, the back-EMF is close to the 17V supply. As the motor speeds up, it will generate more back-EMF and so the voltage we measure will be lower (with respect to +17V).

D5 feeds a 1µF capacitor via a voltage divider consisting of two 4.7kΩ resistors and the resulting filtered voltage is fed to the pin 6 inverting input of op amp IC1b (the error amplifier). It amplifies the voltage by a factor of about two and its output is used to control the pin 3 threshold voltage of triangle generator IC1b via a 100kΩ resistor.

So, as the motor speed drops, the back-EMF decreases, and the DC level from pin 7 of IC1b drops. This causes the triangle waveform generated by IC1a to drop with respect to the DC voltage from speed control potentiometer VR1. This then results in wider positive gate pulses to Mosfet Q1 and more power fed to the motor to maintain the given speed setting.

Trimpot VR6, at pin 5 of IC1b, is included to give some compensation for different motor characteristics; some motors generate more back-EMF than others. VR6 is set so that pin 7 of IC1b is at about mid-supply voltage (ie, 6V) when a motor is connected (more on that in the setting up procedure).

Reverse lockout

Forward and reverse switching is done by RELAY1. This turns on and reverses the loco when the Q output (pin 1) of D-type flipflop IC4a goes high and turns on transistor Q3. IC4a provides the forward/reverse lockout feature whereby the train's direction cannot be changed unless the track voltage is reduced to zero.

This works as follows: IC4a has its data input (pin 5) connected to either +12V via a 10kΩ resistor when the forward/reverse switch (S3) is open or to 0V when S3 is closed. The Q output at pin 1 changes to the level set at pin 5 when a positive clock pulse is fed to pin 3. So if the setting of the forward/reverse switch is changed, the Q output of IC4a will not change until pin 3 gets a positive clock pulse.

In practice, we prevent a clock pulse from arriving until the gate pulses to Mosfet Q1 are stopped. We do this by monitoring the voltage across the 47µF capacitor at pin 5 of IC3b (ie, the speed setting voltage) using op amp IC2d, ie, via the 10kΩ resistor to its pin 13 input.

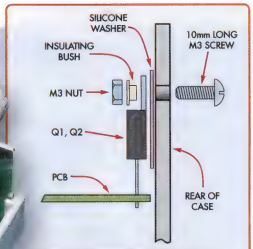


Fig.5: the mounting details for Mosfets Q1 & Q2. The metal tab of each device must be isolated from the rear panel using an insulating bush and a silicone washer.

IC2d's pin 12 is connected to a voltage divider between pin 1 of IC2a and pin 7 of IC2b. Hence, pin 12 will be very close to the minimum speed voltage from IC2b. So until the voltage across the 47µF capacitor drops below this minimum voltage (when the brake is applied, for example), IC2d's output will be low and this will short out any clock pulse to IC4a (ie, from IC1a) by forward biasing D3.

The clock pulses are derived from the output of IC1a, the same op amp that provides the triangle waveform. As soon as the voltage across the 47µF capacitor drops below pin 12 of IC2d, the clock pulses will get through to IC4a. It will then change state and so will the relay.

Finally, op amp IC2c is included to give a power-on reset to IC4a, so that it has the 160Hz clock signal applied to give the correct setting of forward or reverse, as set by the forward/reverse switch. Thus, when power is first applied, the 10µF capacitor at pin 10 of IC2c is discharged and since this is lower than pin 9, IC2c's output is high. As a result, diode D2 pulls pin 13 of IC2d low, so pin 14 of IC2d is high and the clock signal cannot be shunted to 0V by D3. Finally, after about five seconds, the 10µF capacitor charges up, IC2c's output goes high and the forward/reverse lockout facility operates normally.

Construction

Building the Li'l Pulser is easy, with all the parts assembled onto a PCB coded 09107131 and measuring 129.5 x 100.5mm. This is housed in a small instrument case measuring 140 x 35 x 110mm (W x H x D).

Our prototype used an adhesive label attached to the plastic panel supplied with the case for the front panel. However, we're making available a PCB front panel (code 09107132) with blue solder masking, screened lettering and all the holes pre-drilled for a really professional finish. This PCB panel is simply substituted for the supplied plastic panel.

We've also designed a rear-panel PCB (code 09107133) and this has solder-masked copper on both sides to provide heatsinking for the two Mosfets (Q1 & Q2). The mounting areas for the Mosfets are clear of solder masking to improve thermal contact and there are numerous vias between the two sides of this PCB to improve ventilation and heat transfer out of the case.

This PCB rear panel can be used for output currents up to about 5A. This should be more than adequate for the vast majority of layouts, including layouts running double-header (or even triple-header) locos with sound, steam and lighting.

For layouts requiring more than 5A (up to 8A maximum), it's best to use an aluminium rear panel for improved heatsinking (as in the prototype). You will have to cut this aluminium panel to size (134 x 32 x 1mm) and drill the holes yourself (details later). The original plastic panel supplied with the case is discarded.

Fig.4 shows the parts layout on the PCB. Begin by inspecting the board carefully for any defects (rare), then start the assembly by installing the 0.25W resistors. Table 1 shows the resistor colour codes but you should also check each one using a digital multimeter before soldering it to the PCB.

The diodes (including ZD1) can go in next. Be sure to use the correct type at each location and make sure they are all orientated correctly. That done, install the capacitors and the two 0.1Ω

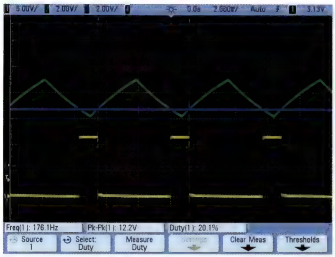


Fig.6: this scope grab shows the operation of IC1a & IC3b. The green trace is the triangle output from IC1a while the blue trace is the DC voltage from speed pot VR1. The resultant pulse (yellow trace) from the output of IC3b is fed to the gate of Mosfet Q1. This is a low speed setting.

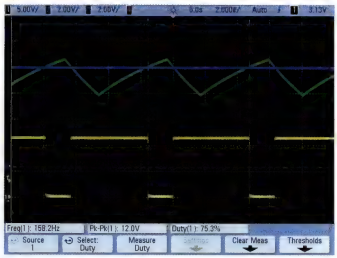


Fig.7: this scope grab shows the same signals as in Fig.6 but now the speed voltage from VR1 is higher, leading to wider positive output pulses from the output of IC3b. This corresponds to almost maximum speed. You can compare these scope grabs with the waveforms shown in Fig.2.

5W resistors (the latter can be mounted flush against the PCB, as they run only slightly warm). Take care with the orientation of the electrolytics – they all go in with their positive leads towards the rear of the PCB.

Follow with the trimpots, relay, piezo buzzer (watch its orientation), switches, potentiometer VR1 and the DC socket. Don't get the trimpots mixed up and be sure to trim VR1's shaft to to suit the knob before soldering it to the PCB. The ICs can then be installed. Make sure their notched ends face the rear of the PCB as shown on Fig.4.

Installing the Mosfets

Regulator REG1 can now go in, followed by transistors Q3-Q5. Note that Q4 is a BC327 while Q3 & Q5 are both BC337s. Don't get them mixed up.

Mosfets Q1 & Q2 can now be installed. First, slip the PCB assembly into the case and secure it by installing the two rear mounting screws. That done, slide the rear panel into position, then mount the two Mosfets on the PCB and temporarily fasten them, along with their insulating bushes, to the rear panel using machine screws and nuts (note: if you are using an aluminium rear panel, you will first have to download the artwork from the SILICON CHIP website and use it as a template drill the necessary holes).

Check that the rear panel is pushed all the way down into its case slot, then carefully tack solder the two outside leads of each Mosfet to their pads on the top of the PCB. The PCB assembly can then be removed from the case and the Mosfet leads soldered on the underside.

The next step is to fit PC stakes to the four external wiring points and to the three test points (TP1, TP2 & TP GND). Follow with the two fuse clips, making sure that each goes in with its end stop towards the outside (otherwise you will not be able to install the fuse).

Installing the LEDs

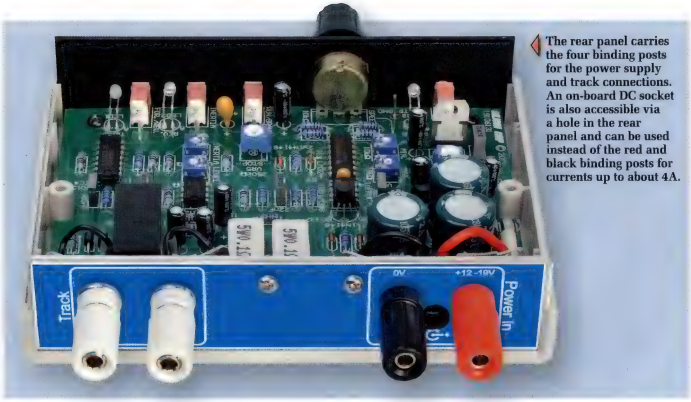
The PCB assembly can now be completed by fitting the three LEDs (LEDs1-3). Use the bi-colour LED for

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
220nF	0.22µF	220n	224
100nF	0.1µF	100n	104
22nF	0.022µF	22n	223
10nF	0.01µF	10n	103

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	4	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	9	10kΩ	brown black orange brown	brown black black red brown
❑	5	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	3	2.2kΩ	red red red brown	red red black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	2	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown
❑	2	0.1Ω	not applicable	not applicable



The rear panel carries the four binding posts for the power supply and track connections. An on-board DC socket is also accessible via a hole in the rear panel and can be used instead of the red and black binding posts for currents up to about 4A.

LED1 (Track), the red LED for LED2 (Reverse) and the green LED for LED3 (Power).

To install the LEDs, first orientate each one in turn so that its anode lead is on the left (as viewed from the front), then bend its leads down by 90° about 8mm from its body. That done, solder the LEDs in place with their horizontal lead sections 5mm above the surface of the PCB (ie, in line with the switch centres).

The easiest way to achieve this is to cut a 5mm-thick cardboard spacer and simply push the LEDs down onto this before soldering their leads.

Final assembly

Now for the final assembly. The first step is to wind a nut onto VR1's threaded bush. Do this nut all the way up, then fit the front panel to the PCB assembly and secure it by fitting a second nut to VR1 (make sure the switches and LEDs all correctly protrude through the front panel before fitting this nut).

Next, fit the four binding posts to the rear panel – red for the +12-19V terminal, black for 0V and white for the two track posts. Once they're secure, attach a 45° 6.3mm chassis-mount spade terminal to each binding post and secure it using the two small end-nuts (see photo).

The spade terminal ends close to the end-nuts should now all be trimmed so that the don't later interfere with the relay and the DC socket when it's all assembled in the case. This can be done using tin-snips and then filing them down. In addition, you will have to trim the ends of the posts so that they protrude no more than about 1.5mm beyond the end-nuts.

If you can only get double-ended spade terminals, it's simply a matter of cutting off the unwanted terminals.

Once the spade terminals are in place, they can be connected to their respective PCB stakes via short lengths of heavy-duty (8A) hook-up wire. Solder these wires to the PCB stakes first, then fit short lengths of heatshrink sleeving over the connections and shrink it down. This will stop the leads from flexing and breaking at the stakes.

The other ends of the wires are then soldered to the spade terminals.

That done, the completed assembly can be installed in the case and the PCB secured to the four corner pillars in the base using four M3 x 5mm screws. Don't worry if the positive binding post terminal touches the adjacent fuse clip, as these are con-

Making Your Own Rear Panel

An aluminium rear panel will be necessary if you intend using the Li'l Pulser to deliver currents above 5A. This panel should be 1mm thick and should be cut to 134 x 30mm.

Once you've cut the panel to size, download the rear-panel artwork (see Fig.10) from the Silicon Chip website at www.siliconchip.com.au (go to "Shop", then "Panel artwork"). Print this out onto both plain paper and photo paper.

The paper version is used as the drilling template while the photo paper version is used as the label. Use a small pilot drill to start the holes, then carefully enlarge them to size as necessary using larger drills and a tapered reamer.

Once the holes have been drilled, the label can be affixed to the lid using a suitable glue or silicone. The holes in the label can be cut out using a sharp hobby knife.

Another alternative is to discard the case altogether and mount the PCB assembly under the layout. You could then mount the speed pot, switches and LEDs on a separate control panel and connect them back to the PCB via flying leads. The two Mosfets can then either be mounted on an aluminium heatsink or fitted with small finned heatsinks.

Another view inside the prototype. Mosfets Q1 & Q2 must be isolated from the rear panel, regardless as to the type of panel used (aluminium or PCB).

nected together on the PCB anyway, so it doesn't matter.

Securing the Mosfets

Regardless as to which type of rear panel is used (PCB or aluminium), Mosfets Q1 & Q2 must both be attached using an insulating bush, insulating washer and an M3 x 10mm screw &

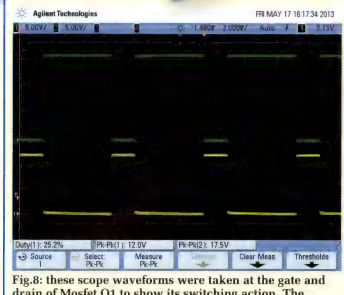


Fig.8: these scope waveforms were taken at the gate and drain of Mosfet Q1 to show its switching action. The yellow trace is the gate waveform from IC3b while the green trace is at the drain and shows the pulses applied to the track, with a resistive load connected. Note that when the gate is positive, the Mosfet switches on and pulls its drain low.

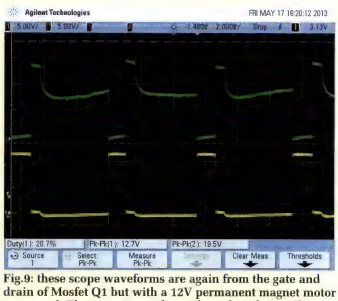


Fig.9: these scope waveforms are again from the gate and drain of Mosfet Q1 but with a 12V permanent magnet motor connected. The green trace shows that when the Mosfet switches off, the voltage at the drain immediately rises to about 17V but then drops due to the back-EMF generated by the motor. At a higher throttle setting, the back-EMF would be higher, leading to a greater drop at Q1's drain.

A hole can be drilled in the lid of the case, above the piezo buzzer, to let the sound escape. The buzzer provides audible indication of a track short circuit.

nut. This is necessary to isolate their metal tabs from the panel. Fig.5 shows the mounting details.

Once they are secured in place, check that their metal tabs are indeed electrically isolated from the PCB copper (or rear panel) using a digital multimeter set to a high ohms range. In each case, you should get a high megohms (or open circuit) reading. If not, undo the assembly and locate the source of the problem.

Finally, a 6mm hole can be drilled in the lid of the case directly above the piezo siren, to let the sound out when an overload is detected. Be careful when marking out the position of this hole for drilling – the lid will only fit correctly in one direction.

Testing

As mentioned earlier, the Li'l Pulser train controller can be powered from a train power supply, a 12V battery charger or from a 15-19V switchmode laptop PC power supply. The current rating of the supply will depend on your individual requirements but around 5A will be more than sufficient for most applications. However, you will need a supply with an 8A rating if you want the Li'l Pulser to deliver its maximum 8A output capability.

Before connecting the supply, go over your work carefully and check that all parts are in their correct locations and that all polarised parts are the right way around. That done, connect the supply to either the DC socket or to the red and black binding posts.

As stated, the DC socket is only rated up to about 4A. If your supply has a higher current rating, use the binding posts to make the supply connections.

The unit can now be checked out by following this step-by-step procedure:
(1) Apply power and check that there is 12V between pins 8 & 4 of IC1 (LM358).
(2) Wind the speed pot (VR1) fully anticlockwise and adjust all trimpots to mid setting.
(3) Check that the brake, inertia and reverse switches are all off (ie, in the up position), then advance the speed pot and check that the track LED lights green. Check that it gets brighter as you wind up the throttle.
(4) Leave the speed pot at a high setting, switch to reverse and check that the reverse LED (LED2) stays off (ie, because of the lockout).
(5) Wind the speed pot down and check that the reverse LED lights when the pot is almost fully anticlockwise. Now wind the speed pot up again; the track LED (LED1) should now be glowing red.

If that all checks out, then the Li'l Pulser is working correctly and you can proceed to set the current limit. That's done as follows:
(1) Connect a multimeter between TP2 and TP GND.
(2) Adjust VR7 for a reading of 50mV for each amp of the required current limit. For example, adjust VR7 for a reading of 150mV for a 3A current limit. Similarly, a 400mV reading will give the maximum 8A current limit.
(3) Short the output terminals and slowly advance the speed pot. Check that the piezo alarm sounds to indicate a short. Note that the fuse should be changed to a lower rating if the current limit (and/or the supply rating) is lower than 8A. Use a fuse rating that corresponds to the current rating of the supply and set the current limit to be equal to or less than this value.

Final adjustments

The final adjustments involve adjusting the minimum track voltage setting, setting the maximum speed and adjusting the inertia and braking trimpots. The steps are as follows:
(1) Set the speed pot (VR1) to minimum and connect the Li'l Pulser controller to length of track with a loco.
(2) Monitor test point TP1 and adjust trimpot VR6 for a reading of 6V.
(3) With the speed pot at minimum, adjust VR2 fully anticlockwise and then slowly clockwise until there is a small amount of track voltage as indicated by noise in the loco motor. Back off the trimpot just a little from that point.
(4) Remove the loco from the track, wind the speed pot fully clockwise and measure the DC voltage across the track terminals. Adjust VR3 for the maximum required track voltage. This is usually set for 12V but you may wish to make this lower to limit the maximum speed of the locos.
(5) With the loco back on the track, check that it runs smoothly as the speed control is advanced. Adjust the inertia trimpot (VR4) and the brake trimpot (VR5) to give the required simulated inertia when accelerating and braking.

Note that advancing VR4 past its mid-setting can also have an effect on the minimum speed. That means you may need to readjust the minimum and maximum speed settings (steps 3 & 4 above) after adjusting VR4. SC

Fig.10: this rear-panel artwork can be copied or downloaded from the SILICON CHIP website and used as a drilling template for an aluminium rear panel. For output currents up to 5A, use the suggested PCB rear panel (see text).

Secure Digital Cards - Clearing Up the Confusion

Secure Digital cards and their smaller siblings, Mini and MicroSD cards have become the defacto standard for flash memory storage, winning out over competitors such as Compact Flash due to their smaller size, constantly increasing speed and capacity as well as widespread device support. But there are many different kinds of SD card and here we take a look at the differences between them and some of the technology behind them.

Take a look on the shelf of a store selling flash memory cards (or on the web page of an online retailer) and you will find many different kinds of SD cards: SD, SDHC and SDXC with a speed rating of Class 0, Class 2, Class 4, Class 6, Class 10, UHS-I (ultra high-speed) and so on. Each type is generally available in a variety of capacities and brands in both full-size, mini and micro format.

MiniSD and MicroSD cards, by the way, can be be used in devices expecting full-size SD cards with the use of a passive adaptor.

In many cases, this adaptor, which is exactly the same size as a standard SD card, comes with the Mini or MicroSD card.

That's a lot of different options – possibly hundreds. The various "classes" refer to the read/write speed that the card can manage and this is important if you are going to use it in a video camera or digital SLR still camera - especially with a video camera as a slow card will limit the video quality you can record at.

Just how fast the card needs to be for a video camera depends on the shooting resolution (eg, 640x480, 1280x720 [720p] or 1920x1080 [1080p]), the frame rate and the video compression format being used. Some newer cameras can even record in resolutions above 1080p such as "2.7K" (eg, GoPro Hero 3 Black). The SD card being used for recording needs to be pretty fast to keep up.

A micro SD card, also known as a "Transflash" Card.

The main difference between SD, SDHC and SDXC is the maximum capacity that type of card can have, although higher transfer speeds are also restricted to the newer SDHC and SDXC formats. But some devices may not support all the latest types of SD card; generally this will mean the performance is restricted although in some cases, it may not work at all.

Card classes

Some SD cards indicate a speed in MB/s, or relative to CD speeds (eg, 600x = 90MB/s). But those ratings can be a bit "optimistic" so the SD Card Association came up with an official class rating system.

If a card is "Class 0" or doesn't indicate a class at all (and isn't a UHS type) then that means the speed isn't guaranteed. It isn't very common to see such a device any more and this type of card would best be used in an application where speed is not critical, eg, data logging.

Cards labelled class 2, 4, 6 or 10 (the logo being a number inside a big "C") indicate the minimum sustained write speed, in megabytes per second, of the card in an unfragmented state. In addition, classes 2, 4 and 6 assert that the card's write speed must degrade gracefully as the free space on the card becomes increasingly fragmented. This occurs as files are repeatedly written and deleted.

Class 2 is reckoned to be fast enough for recording standard definition video while class 4 is required for HD video. Class 6 offers improved HD recording quality or higher frame rates.

Class 10 is identical to class 6 except in the case where the recording is going to a completely empty area of the SD card (eg, after formatting the card),

by Nicholas Vinen

where the minimum continuous write speed must be at least 10MB/s.

Card labelled UHS-I or UHS-II use a faster interface with the host device/computer and generally are indicated as either "speed grade 0" (<10MB/s) or "speed grade 1" (>10MB/s). This latter speed grade is indicated with a 1 inside a U and most UHS-I cards will manage at least 10MB/s. This is effectively the same as Class 10.

Note that to achieve the rated performance, you must used a particular file system on the card, for reasons explained below.

That means you shouldn't reformat an SD card unless it is absolutely necessary, as the newly formatted file system may not be the correct one for best performance. If you must format it, there is a utility available from the SD Card Association (see link at end of article) which will do the job properly.

Card types and file systems

The latest type of SD card is called SDXC for eXtended Capacity which allows capacities up to 2048GB (2TB). The previous generation is SDHC for High Capacity which supports up to 32GB. There is some cross-over with 32GB cards available in both types.

Besides the increased maximum capacity, there is relatively little difference between SDHC and SDXC cards. In fact they are similar enough that SDXC cards up to 128GB will work in some devices designed before SDXC came along. The main issue with backwards-compatibility is in the file system.

All SDXC cards come formatted with exFAT which is a new version of the FAT file system ("file allocation table"), designed to support higher capacities.

Unfortunately, this is not a license-free format and it is currently proprietary to Microsoft although some third-party software allows access to exFAT from other operating systems such as Linux.

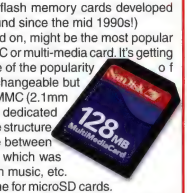
This also means though that older versions of Windows (before Vista SP1) and MacOS will not be able to access the contents of SDXC cards.

However, FAT32 actually works for capacities up to about 2TB. So for SDXC cards, you have the option to re-format them with FAT32 and they will then work in most devices, with the caveat that the maximum file size is then 4GB.

Other types of flash memory cards

There have been several different types of flash memory cards developed over the years (years? They've only been around since the mid 1990s!)

SD cards, which this article has concentrated on, might be the most popular but they are in fact a spin-off from the earlier MMC or multi-media card. It's getting difficult to find MMC cards these days because of the popularity of SD cards. The two are often considered interchangeable but that's not strictly true. SD cards are thicker than MMC (2.1mm vs 1.4mm) so MMC cards will usually fit into a dedicated SD reader; the reverse is usually not true. The file structure is also slightly different but the main difference between the two is that "secure" area (hence SD card) which was first developed for digital rights management in music, etc.



Transflash is simply another name for microSD cards.

Still fairly popular and relatively easy to get are Compact Flash cards, although they too have largely given way to SD cards. The main reason for this is size – CF cards (there are actually two, CFI and CFII) are significantly larger than even standard SD cards; the difference between CF and micro SD is quite dramatic. 32GB CF cards are common, 64GB are also available but not common. Expect to pay between $200 and $300 for a "brand name" 64GB CF Card; by contrast a "brand name" 64GB Class 10 SD card shouldn't cost much more than $100 and we've seen them for as low as $40. But compare these to the latest Lexar 256GB C10 (600x speed) SDs which sell for close to $1000!

Another card which was (briefly!) popular was the SmartMedia Card. As far as we can tell, the maximum size this card was ever made in was 128MB (yes, megabytes) and even in their day, were expensive. Similarly the MiniCard went the way of the dodo, despite being promoted as "the standard" back in the mid 90s. Its main claim to fame was that it used the PCMCIA (later PC) bus, though this did not lead to its longevity!

Some manufacturers have tried to be clever by bringing out their own proprietary flash memory cards to lock others out of their systems. Companies such as Sony with their Memory Stick and Memory Stick Pro, and the Fuji/Olympus XD card, are two such examples.

Once again, proprietary cards were usually more expensive (often significantly so) than their SD counterparts and the XD card, for example, was never available with more than 2GB capacity. While physically smaller than SD cards, XD cards are nevertheless larger than mini or micro SD. Newer models of Fuji/Olympus cameras support both XD and SD or, lately, SD only.

Similar comments can be made for Sony's Memory Stick and Memory Stick Pro – their latest cameras support both their stick and SD cards. And Sony has also released their own SD cards. However, Sony still supports the Memory Stick format, which is currently available up to 64GB and has a maximum theoretical size of 2TB (Memory Stick Pro). A 64GB model usually sells for around $100.

This is by no means an exhaustive list of all types of flash memory cards. Wikipedia, for example, lists 25 different card types, although several of these have sunk without trace and others may not be available in this country.

SD cards – in all their iterations – remain a pretty safe bet . . . at least until something newer and better comes along!

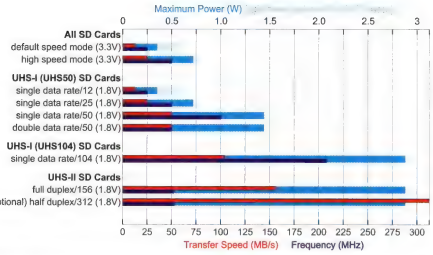


Fig.1: peak read/write speeds for SD cards in various modes. Each type of card should support the modes listed above it, ie, UHS104 cards also support the modes for UHS50 and regular SD cards. Transfer speed is shown in red (bottom scale) and clock frequency in blue (bottom scale) while maximum power consumption is in cyan (top scale).

But there are a couple of problems with reformatting SD cards. Problem number one is that for some unknown reason, most versions of Windows refuse to format a volume larger than 32GB with the FAT32 file system – even though they will happily read and write such a volume.

This can be solved by the use of a third-party formatting utility such as "guiformat", which is a graphical version of "fat32format" (www.ridgecrop.demon.co.uk/guiformat.htm).

The other problem is that reformatting an SD card with a different file system (or even different options) can seriously impact its performance. That's because, for efficient writing of large files, the card controller needs to know which flash blocks are free and which are used. That's so when writing a partial block, it knows whether or not it has to preserve the rest of the block, which takes extra time.

Since all SDXC cards are designed for use with exFAT, when reformatted with FAT32 writing may be dramatically slower. Also, the "wear levelling" algorithm may not work as well, leading to a shortened life. We'll explain that later.

Actual size comparison between the original SD card, (top, 32 x 24mm), a MiniSD, (centre, 21.5 x 20mm) and a MicroSD, (bottom, 11 x 15mm). Card capacity has no bearing on dimensions. Only the standard SD card features a write/erase lock (left side).

Protected area

So what makes Secure Digital cards "secure" exactly?

It's the protected area, which we believe is hardly ever used any more. This allows data to be stored in an encrypted format and is supposed to be used to restrict access to copyright content on an SD card.

The stated capacity of an SD card includes this protected area, which is why you can never quite fit as much on an SD card as you think you should.

As SD card capacities have increased (and, we suspect, manufacturers have realised how few applications there are for this protected area), the proportion of the flash memory available for general storage has increased. For example, a 4GB Toshiba SDHC card has a 32MB protected area (0.8%) while their 8GB card has a 48MB protected area (0.6%).

High-speed interfaces

The UHS-I and UHS-II high-speed interfaces were introduced along with the new SDXC card format but support for them is optional. SDHC cards may optionally support UHS modes as well.

The main difference between them is that UHS-I is physically compatible with the older SD card interface and offers somewhat higher speed operation while UHS-II introduces additional contacts on the card and so requires a new type of socket but offers higher speeds again.

Before UHS-I, the fastest speed SD card interface available was "high speed" mode, giving a burst speed up to 25MB/s (see Fig.1). UHS-I introduces several new modes, all operating with 1.8V signalling.

It is well known that lower voltage signalling allows higher transmission speeds, due to slew rate limitations such as parasitic capacitance and so on. So UHS-I doubles the maximum speed, to 50MB/s.

This can be achieved either with a doubling of the clock, up to 100MHz, or else by sticking with the same 50MHz clock rate as before but transferring four bits of data on both the rising and falling edge of the clock signal, ie, double data rate (DDR). This is a common technique and has been in common use for PC RAM for over ten years now.

In either case, the UHS-I card is allowed to draw up to 1.44W while active or nearly 500mA at 3.3V, twice what a regular high-speed SD card is allowed to draw (ie, 0.72W) and four times the maximum that a regular SD card normally draws in low-speed mode (0.36W).

While signalling in the UHS-I modes occurs at 1.8V, the card still runs off 3.3V. It must step down this voltage internally and this provides one of

While SD cards have dramatically increased in capacity over the years, they've shrunk in size – first to mini, as seen above, and more recently to micro (or Transflash). This has enabled backwards compatibility using adaptor as seen at right (in this case for MiniSD) Mini or Micro SD cards slide inside the adaptor and so can be used in devices with full-size SD card sockets.

Demonstrating just how little space is actually used inside the SD card, this 32GB Transcend model also houses a complete WiFi transceiver, which allows you to send your photos direct to you computer without the card ever leaving your camera. We reviewed the original "Eye-Fi" Connect X2 SD card back in the October 2010 issue – it was only a 4GB card and the storage (ie, SD) side has since failed with constant use.

How much can you store on an SD Card?

	2 GB	4 GB	8 GB	16 GB	32 GB
Movies (minutes)					
(Hi-def movie recording MPEG-4; H.264)					
Fine mode (13Mbps/CBR)	20m	40m	80m	160m	320m
Normal mode (9Mbps/VBR)	30m	60m	120m	240m	480m
Economy mode (6Mbps/VBR)	45m	60m	180m	360m	720m
Photos (number)					
(10 Megapixels, 3648x2736, Fine mode)	770	1,540	3,080	6,160	12,320
Music (hours and minutes)					
(ACC, MP3 HQ mode, 128Kbps)	34h 7m	68h 14m	136h 27m	272h 54m	545h 48m

Typical capacities of various size SD cards for movies, photos and music. Actual capacities may vary, depending on file size and compression used.

the limitations for UHS-I performance and is why UHS-II was devised at the same time.

Even faster cards

Faster UHS-I cards can optionally support UHS104 mode. In this mode, the card can draw even more power, up to 2.88W or nearly 1A. Maximum transfer rate is increased again, to 104MB/s by a further increase in the clock rate to a maximum of 208MHz. UHS104 mode does not support DDR.

To operate correctly with such a high clock frequency, the SD card host must first interrogate the card for some "tuning" information which tells it about the timings for this specific card, possibly including calibration values programmed into the card at the factory to account for process variations and other factors. The host must then adjust its signal timing to match for reliable transfers.

Despite all these new modes, UHS-I cards (and indeed UHS-II cards) generally remain backwards-compatible with older host devices.

That's because most of these new features must be activated by the host, once it has determined that the card supports them.

When first powered up, these cards initially operate in the standard, low-speed mode and the specification requires them to support all the older modes including the regular high-speed mode and so on.

So to get the advantages of the new high speed modes, both the card and host device must support them. And of course, the flash in the card has to be fast enough, otherwise faster signalling doesn't get you anything much.

In fact, a UHS-I card is not necessarily any faster than a Class 10 SD card or even a Class 6 card. Many newer devices such as digital cameras support UHS-I cards and there are quite a few such cards now available, some claiming transfer speeds of up to 90MB/s in ideal conditions.

While not part of the official SD specifications, because UHS-I/Class 10 are so vague as to the actual performance of the card, some manufacturers still specify the peak speed in order to differentiate their products from slower competitors which may be in the same class.

Yet more speed

UHS-II adds eight new pads to the SD card: three grounds, a dedicated 1.8V supply and two pairs of differential signalling lines. Differential signalling is another common technique for increasing transfer speeds and is used by USB, Ethernet, PCI Express, HyperTransport and many other communication technologies.

The two signalling "lanes" can be used either to send and receive data simultaneously (full duplex) or configured to operate in the same direction for faster reading or writing (half duplex).

The number inside the "C" symbol (ringed in red here) shows the speed of the card – in this case, it's a Class 10 which is suitable for use in video cameras and similar devices requiring a high speed data transfer. If there is no symbol shown (as in the card on the opposite page) no claim is made to its class (speed) and therefore it can be assumed to be the lowest speed. Such cards are cheap but they are really only suitable for non-demanding applications such as data logging.

UHS-2 is similar to the commonly used LVDS (low voltage differential signalling) protocol but with an even lower voltage swing. The signal lines are operated as transmission lines to allow such a high speed and by sending one bit at a time, edge alignment of multiple signals due to different path lengths is no longer an issue.

In UHS-II mode, the normal SD card power supply contact remains at 3.3V and a differential clock signal is applied to pads 7 and 8, which were previously used for data transmission. This clock operates at a fraction of the data transmission frequency, generally 25-50MHz, while the data signals can be up to 1.5Gbps.

Obviously UHS-II operation is quite different from UHS-I but the cards will be backwards compatible. We aren't aware of any UHS-II cards on the market just yet, nor any devices which can take advantage of them.

Wear levelling

Flash memory does not have an infinite life – there is a limit to how many times a block of flash can be written to before it becomes unreliable, ranging from as few as 100 up to millions of times.

So most flash memory storage devices use some kind of "wear levelling", which "spreads the load" of data storage to areas of the device which might otherwise remain unused.

Consider an SD card used in a digital camera, where a few photos are taken each time the camera is used and those files are then moved off onto a computer. New files are normally placed at the beginning of the card.

What causes memory card failure?

Memory card failure happens more often than we would like. We are referring to both data corruption and a complete loss of function (and thus data). The most obvious cause would be physical damage; SD cards are small enough that they can easily be dropped, stepped on, bent, split open and so on. There's only one way to avoid that and that's to handle with care! Incidentally, the SD card standard calls for them to be able to handle just a 3m drop.

We've also heard that physical wear can be an issue, ie, if you insert and remove an SD card often enough, the contacts can wear out, both on the card and in the host device. You'd have to be doing an awful lot of insertions and removals to end up in that situation though.

Ignoring physical damage, you have two classes of failure. The first is where the memory card itself works fine but files inexplicably vanish or in the worst case, the card isn't even recognised as valid by the computer. This can happen if the card has been removed from a device while it is being written to, due to a bug in a device you have plugged it into or when it's on the verge of failure from the flash memory reaching its end-of-life.

If the card is still recognised but files are missing or otherwise corrupt, you can try using one of the various pieces of software which attempt to recover files from damaged cards. There are many free ones available, some of which works quite well and others which... don't.

The simplest type of recovery you can attempt is to simply check the device for file system errors and recover any "lost" files. This can often be done simply by running a "scandisk" tool on it, which is generally built into your operating system. In Windows, this is accessed by right-clicking on the drive letter, going to the Properties dialog and then the Tools tab and clicking the "Check now" button.

If you're lucky, the missing files will be placed in the root directory or in a folder created for them. Their file names may be scrambled but hopefully the contents are OK.

You could also try a program like CardRecovery/CardRescue or one of the other programs available on the 'net for this type of job. Some are free while others may have a trial version that will at least let you check that you can recover some files before forking out for the full version.

Sometimes, the SD card controller or flash memory chip can fail entirely. The result is usually that the card is no longer detected as valid in any device. Windows Disk Management may not listed or if it is listed, shown it as "No Media" or containing no valid partitions.

If there's important data on it, your only choice then is to go to a recovery professional (look up "data recovery" in the Yellow Pages). This won't be cheap but they should have specialised gear and thus are likely to be able to get some or all of your data back. If there isn't any critical data on it, you're better off binning and buying a new (and probably bigger and faster) card.

Besides manufacturing faults, the most likely reason for the total electrical failure of a memory card is either a static discharge to its contacts or voltage spike from something you plugged it into.

If you have more than one card fail, you may may have a faulty piece of gear which is damaging them; possibly the last thing you used that card in.

So if data is simply stored in a block based on its storage address, that area of flash will be constantly written to while the rest may be left largely untouched.

Even though there's plenty of working memory remaining, if these first blocks are used again and again the card will quickly become useless.

The primarily solution is to rearrange where data is stored in the flash memory and keep track of what is stored where using a mapping table which says where data was written to versus where it is actually stored. This way, the controller can perform subsequent writes to different flash blocks even if they are at the same storage address.

So writes can be spread out evenly among the flash blocks and thus you get the maximum possible lifespan. In other words, this technique evens out how quickly the flash blocks wear out, hence "wear levelling".

But for this to work, the controller must know which blocks are free; it can only cycle through writing to unoccupied blocks of flash. So if the card is nearly full or if a file system is used that the controller doesn't understand then wear levelling is no longer effective.

A related strategy used to extend flash life is to have more flash blocks than necessary for the stated capacity of the device (say 1% extra).

Some blocks of flash in use may wear out much sooner than others and when that happens, these can simply be marked as bad and skipped over. As long as there are enough spare blocks left, there's still enough space to store the full data capacity.

It's possible for the controller to determine when a block is going to wear out when reading it based on how close the stored voltages are to the thresholds which determine whether a given bit is read as a zero or a one.

If this voltage (which changes with use) is too close to the threshold then the block can no longer be considered reliable and can be disabled.

Something you'd hope to never see: the inside of a typical SD card. The large "hynix" chip at the bottom is the actual flash memory (in this case 16Gbit); the smaller "blob" above it would be the controller.

Further details

The SD card standard is rather complex; the simplified version runs to 186 pages and this covers only the electrical characteristics of the cards themselves. The host controller specification is separate, as is the description of the protected area and the various extensions to the standard such as SDIO (for WiFi and Bluetooth adaptors in the SD card format).

Hopefully we've covered the more salient points here and given readers the knowledge required to work out which card to buy for a given application.

For more information, refer to the SD Card Association website – and specifically the downloads page, at **www.sdcard.org/downloads/pls/** sc

Jaycar Electronics
Better, More Technical

WINTER PROJECTS

Prices valid until 20/07/2013

JULY EDITION

DIY Electronics Tool Kit

Total Package valued at $106.75 save $21.80

An awesome DIY electronics tool kit which includes a 19 range digital multimeter (QM-1523 $14.95), 20/130W soldering iron starter kit (TS-1651 $24.95), 7 screwdrivers (TD-2022 $19.95) that are approved to 1000V. Five stainless steel 115mm cutters and pliers (TH-1812 $29.95) and a 4 Tray tool storage case (HB-6302 $16.95).

$84.95

Economy 4 Channel DVR

Designed for small surveillance systems in the home or office. Capable of recording full D1 (704 x 576) resolution at 25 frames per second on each channel. Supplied with a 500GB HDD to store up to 300 hours of continuous video it can also be configured to trigger from a timer or motion detection. Connect to a computer network to view video remotely using a web browser or Smartphone/iPhone® (via installed app). See in-store for range of cameras.

- H.264 Compression
- Composite and VGA video output
- Size: 300(L) x 210(W) x 50(H)mm

QV-3029 ***was $279.00***

$249.00

SAVE $30

Arduino Experimenters Kit

Learn about the exciting new world of Arduino with these easy to build projects. From flashing an LED to moving things with a servo. Complete with instructions and a supporting web page and software examples.

- No soldering required

XC-4262

$89.95

Desk Mount LED Laboratory Magnifier Lamp

High quality, all metal frame construction magnifier which features 90 super bright LEDs and handle for quick repositioning. A great tool to assist PCB assembly/inspection, jewellers, stamp/coin dealers, etc.

- 120mm, 3 x magnification lens
- 2m long cord
- Mains powered
- Total extended length 900mm

QM-3546

NEW **$119.00**

Rechargeable LED Work and Floodlights

A range of mobile LED work lights for those who need lots of light without a mains connection. Built-in rechargeable batteries.

- Burn time: up to 4-5 hours
- IP65 rating
- Mains charger included

RECHARGEABLE

30W 1500 Lumen Work Light

- Size: 350(H) x 210(W) x 219(D)mm

SL-2886 $139.00

SL-2886

10W 500 Lumen Floodlight

- Size: 115(L) x 85(W) x 85(D)mm

SL-2887 $69.95

30W 1500 Lumen Floodlight

- Size: 225(L) x 185(W) x 125(D)mm

SL-2889 $129.00

NEW FROM **$69.95**

SL-2887/SL-2889

USB Port Voltage Checker Kit

Ref: Silicon Chip Magazine July 2013

An easy way to test a USB port to see if it is dead, faulty or incorrectly wired to help prevent damaging a valuable USB device you plan to connect. Voltage is indicated using three LEDs. Kit supplied with double sided, soldermasked and screen-printed PCB with SMDs pre-soldered, clear heatshrink, USB connectors and components for USB 2.0 & 3.0.

- PCB: 44 x 17mm

KC-5522

DUE EARLY JULY

NEW **$29.95**

25W Soldering Iron Starter Kit

The ideal starter package for electronics enthusiasts or the home handyman. Includes a digital multimeter, soldering iron, de-soldering tool, screwdrivers, pliers and side cutters.

- 25W

TS-1652

$34.95

JAYCAR ROCKINGHAM WA

We have MOVED!

Cnr Read & Patterson Rd Rockingham 6168 WA

Ph: (08) 9592 8000

5MP USB 2.0 Digital Microscope with Stand

The microscope can capture images up to 5MP (2592 x 1944) and video at 1280 x 960 pixels. Excellent for educational purposes or a myriad of practical applications such as technicians, jewellers, laboratory work, and much more.

- Still image capture resolution: 2592 x 1944, 2048 x 1536, 1600 x 1200, 1280 x 960 pixels
- Microscope size: 110(L) x 33(Dia.)mm

QC-3199

NEW **$129.00**

Video Doorphone with RFID Access

All the standard doorphone features to screen visitors at your door, and an RFID sensor so frequent users can enter using an RFID tag. Includes one regular RFID tag and two tags to program & remove tags from the system. Door locks are available separately to remotely lock/unlock the door. Cat5/6 cable required between camera and monitor.

- 2.5" colour LCD
- Monitor size: 180(H) x 79(W) x 33(D)mm

QC-3622

NEW **$249.00**

Spare RFID tag available separately

QC-3623 NEW $9.95

Osram LED Torch

High brightness torch featuring 6 x ultra bright warm white Olson Osram LEDs. Great addition to your fishing tackle box or keep one in the car for emergency situations.

- Requires 4 x AA batteries
- Size: 190(L) x 60(Dia.)mm

ST-3486

NEW **$19.95**

To order call 1800 022 888 **www.jaycar.com.au**

WORKBENCH EQUIPMENT

10MHz Handheld Scope DMM

Smartly combines a well featured digital oscilloscope and a 4,000 count True RMS digital multimeter into one versatile package. Features a USB interface and PC logging software to match. Perfect for laboratory work or for technicians working in the field.

- 128 x 128 graphic LCD display
- Autoranging
- Size: 186(L) x 86(W) x 32(D)mm

QM-1577

$399.00

Dataloggers

These USB dataloggers log temperature and humidity readings and store them in internal memory for later download to a PC. The measurement interval is adjustable - simply set up the recording parameters then download the data when needed.

- Mounting bracket and software included

USB Temperature/Humidity Datalogger

- Direct plug-in type
- 32,000 memory samples
- Size: 100(L) x 22(W) x 20(H)mm

QP-6013 ***was $119.00***

$99.00 SAVE $20

USB Temperature/Humidity Datalogger with LCD

- USB / LCD readout type
- 32,700 memory samples
- Size: 95(H) x 50(W) x 32(D)mm

QP-6014 ***was $179.00***

$149.00 SAVE $30

PCB Holder with Magnifying Glass

An extra pair of hands and eyes for those fiddly jobs. Supports PCBs while soldering etc. Features 90mm magnifying glass and two alligator clips.

- Size: 78(L) x 98(W) x 145(H)mm

TH-1983

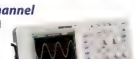
$12.95

Digital Storage Oscilloscopes

- Includes 2 x 10:1 probes, EasyScope interface software and USB cable

25MHz Dual Channel

Ideal for the advanced hobby user or technician and is particularly suited to audio work. See online for more details.



- 145mm colour TFT LCD
- Size: 310(W) x 150(H) x 130(D)mm

QC-1932 ***was $499.00***

$449.00 SAVE $50

Adel Nibbling Tool

Ideal for chassis-bashing and all sorts of hobby applications. Cut, notch or trim simple or complex shaped holes in plastics, laminates, leather or metal.

- Made in USA

TH-1765 ***was $69.95***

Spare punch

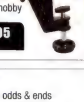
TH-1767 ***was $39.95***

now $29.95 save $10.00

$59.95 SAVE $10

Mini Bench Vice

This strong lightweight aluminium vice will clamp to surfaces up to 1" (25mm) thick and hold material up to 2" (50mm) thick. Great for hobby work or for repairs on the go.



TH-1764

$14.95

Large Bargain Bag

An ideal addition to the venerable odds & ends collection for technicians or enthusiasts. These bargain bags contain over 1.8kg of components, doodads, and whats-a-ma-call-its gathered from our vast array of sources. You are sure to find something useful and will probably find something invaluable.

- Over 1.8kg

XB-9000

$24.95

100MHz Dual Channel with 7" Screen

Enhanced performance, professional level test instrument for the technician, design engineer or development laboratory. Includes a carry bag. See online for more details.

- 178mm colour TFT LCD
- Size: 340(W) x 150(H) x 110(D)mm

QC-1934 ***was $899.00***

$849.00 SAVE $50

48W Temperature Controlled Soldering Station

Ideal station for the advanced hobby user. It features accurate analogue temperature adjustment, ceramic element and a lightweight pencil that will give you hours of fatigue-free soldering. The stand has spare tip storage and is very sturdy.

- Power: 48W
- Temperature range: 150 - 450°C
- Lead-free rated
- Size: 150(L) x 115(W) x 92(H)mm

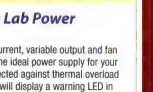
TS-1564

Spare pencil & tips available separately

$99.00

Switchmode Lab Power Supplies

Compact size, high current, variable output and fan cooling make these the ideal power supply for your bench. They are protected against thermal overload and short circuit and will display a warning LED in the event of a fault condition. Current and voltage are displayed on separate backlit analogue meters.



- Size: 148(W) x 162(D) x 62(H)mm

0 - 24VDC 15A MP-3800 **$149.00**

0 - 16VDC 25A MP-3802 **$199.00**

Limited quantity

Jaycar DIY Kits

Do Not Disturb Phone Timer Kit

Ref: Silicon Chip Magazine May 2013

Stop those annoying and intrusive phone calls when you don't want to be disturbed. Set the timer duration between 15 to 120 minutes and the caller will get an engaged signal until the timer times out. Kit supplied with silk-screened PCB, black enclosure (83 x 54 x 31mm) with label, pre-programmed PIC, PCB mount components and phone lead.

- Five times settings: 15, 30, 60, 90 and 120 minutes
- Automatically returns phone to "ready" (on hook) after time-out
- Works with multiple phone extensions in house

KC-5521

Telephone not included

$29.95

Garbage and Recycling Reminder Kit

Ref: Silicon Chip Magazine Jan 2013

Easy to build kit that reminds you when to put which bin out by flashing the corresponding brightly coloured LED. Up to four bins can be individually set to weekly, fortnightly or alternate week or fortnight cycle.Kit supplied with silk-screened PCB, black enclosure (83 x 54 x 31mm), pre-programmed PIC, battery and PCB mount components.

- PCB size: 75 x 47mm

KC-5518

$29.95

Bargain Capacitor Pack

This pack (which weighs about 500g) is astonishing value. It has probably over 200 parts (we don't have time to count, so you reap the benefit). What we can say is that it has lots & lots of expensive US made electrolytics – including a bonus really big one! It includes German WIMA metallised polyesters, other plastic film & ceramic types in both axial & single ended cases. Wire leaded parts and SMDs. A strong addition to your parts bin.

RE-6260

$14.95

Limited stock. Be Quick!

To order call 1800 022 888

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/07/2013.

TOOLS

Non-Contact Thermometer with Dual Laser Targeting

Measure the temperature of a surface from a safe distance. Dual laser sighting for accuracy. Temperature range: -50 to +650 degrees C.

- Laser pointing targeting
- Wide temperature range
- 12:1 Dist. to spot ratio
- Backlit LCD
- Holster included
- Size: 146(L) x 104(W) x 43(D)mm

QM-7221

$99.00

32 Piece Precision Driver Set

High quality set for all those delicate jobs. Tactile handle with hardened hex shaft that extends from 140 to 210mm. Ideal for model making, electronics etc.

- Slotted, Phillips, Pozidriv, Torx and Hex
- Case size: 157(L) x 100(W) x 27(D)mm

TD-2106

$17.95

Thread Repair Kits

These thread repair kits will enable you to drill out a stripped or otherwise damaged thread in a blind hole. Available in M3, M4, M5 and M6 sizes. 10 inserts included in kit.

NEW **$24.95** EACH

M3 Threads HP-1600 $24.95
M4 Threads HP-1602 $24.95
M5 Threads HP-1604 $24.95
M6 Threads HP-1606 $24.95

400A AC/DC Clampmeter

Easy one-hand operation makes this meter perfect for the working installer or tradesman. A quality, intermediate-level clampmeter with current ranges up to 400 amps AC and DC.

- Data hold, non-contact voltage, relative measurement
- Autoranging
- Auto power off
- Diode test
- Jaw opening 30mm
- Size: 198(H) x 66(W) x 36(D)mm

QM-1563

$119.00

Heavy Duty Terminal Crimper

Used for crimping lug/eye terminals onto heavy gauge power cables. Features a built in rotating die which can be rotated to suit terminals for 6/10/16/25/35/50mm² cable (10AWG-1/0AWG).

- Suitable for use with our PT-4934 to PT-4939 range of eye terminals
- 450mm long

TH-1849

$49.95

Enclosures with Mounting Flange

IP65 ABS Enclosures

- Moulded in dark grey with mounting flange
- Designed to IP65 of IEC529 and NEMS 4 (dust and hose proof)

HB-6121 $6.95
Box: 64(W) x 58(D) x 35(H)mm
HB-6123 $9.95
Box: 115(W) x 65(D) x 40(H)mm
HB-6138 $10.95
Box: 115(W) x 65(D) x 55(H)mm

NEW FROM **$6.95**

See online for full range of Sealed ABS Enclosures

IP65 Diecast Aluminium Boxes

Sealed aluminium enclosures for external use are provided with flanges and holes for wall mounting. Made from aluminium alloy ADC-10 (JIS) and provides protection against dust and moisture (IP65).

NEW FROM **$10.95**

- Flanged mount

HB-5029 $10.95 Box: 90(W) x 36(D) x 30(H)mm
HB-5031 $11.95 Box: 64(W) x 58(D) x 35(H)mm
HB-5044 $23.95 Box: 115(W) x 90(D) x 55(H)mm
HB-5041 $36.95 Box: 171(W) x 121(D) x 55(H)mm

IP65 Polycarbonate Enclosures

- Moulded in light grey
- Designed to IP65 of IEC 529 and NEMA 4 (dust & hose proof)

with Mounting Flange:
HB-6213 $12.95 Box: 115(W) x 65(D) x 40(H)mm
HB-6221 $25.95 Box: 171(W) x 12(D) x 80(H)mm

NEW FROM **$12.95**

with Clear Lid and Mounting Flange:
HB-6249 $14.95 Box: 115(W) x 65(D) x 40(H)mm
HB-6251 $17.95 Box: 115(W) x 90(D) x 55(H)mm
HB-6223 $28.95 Box: 115(W) x 121(D) x 80(H)mm

3-in-1 Function Heat Blower & Soldering Iron

A handy unit with flame or flameless heat blower and soldering iron function. Great for general heating, drying, melting, soldering, heat shrinking etc.

FREE Butane Gas worth $5.95

- Piezo ignition
- Up to 500°C
- Size: 148(L) x 35(W) x 23(D)mm

TH-1604

Butane gas 150g: NA-1020 $5.95

$29.95

Portasol Pro Piezo Gas Soldering Tool Kit

This kit contains a Portasol Pro Piezo Gas Soldering Iron, cleaning sponge and tray, 2.4mm double flat tip, hot air blow, hot knife tip, hot air deflector and flame tip.

- Quality storage case

TS-1318

$129.00

Aerosol Dust Remover

Helps remove dust from electronic, electrical and optical devices. It does not leave a residue, is non toxic and non conductive. Non CFC and nonflammable.

- 250mL can

NA-1018

$19.95

BUY 2 for $30 SAVE $9.90

Handy Magnet Strip

Attach the handy rare earth magnets to walls, tables or other surfaces to hold tools, brushes, scissors, key rings or any other object that contains iron.

- 9 pieces, 750mm long

LM-1624 *was $19.95*

$14.95 SAVE $5

Accessories not included

Smart Lighting

15W Downlight Kits

Lighting our way to a more energy efficient future are the new 15W Ecolume LED downlight kits. These 100mm LED downlights are powered by six OSRAM LW3 LEDs. Each downlight kit is supplied with a dimmable LED driver and the adjustable gimbal housing finished in white colour.

- Mains powered

Warm White 906 Lumens
ZD-0373 *was $99 now $89 save $10*
Neutral White 966 Lumens
ZD-0376 *was $99.95 now $89.95 save $10*

NEW FROM **$89.00**

Deluxe Power Meter

Monitor the energy consumption of an appliance with the added convenience of being able to read the large LCD screen via an extension cord.

- Displays wattage, voltage and cost usage
- Supplied with 1 metre extension cable
- Size: 159(L) x 73(W) x 38(H)mm

MS-6119

NEW **$29.95**

12VDC E14 Base LED Globe

Drawing just 5W of power and producing around 450 lumens of light, this LED globe is an excellent solution for energy efficient lighting. Fitted with E14 screw base.

- 12VDC
- Cool white (5500K)

SL-2851

NEW **$24.95**

Cigarette Lighter Adaptors & Splitters

A new exciting range of 12/24VDC adaptors to suit a variety of cars or trucks.

12V/24VDC Cigarette Lighter Socket with USB Port

Allows you to power a USB gadget while still keeping your cigarette lighter socket available.

- Overall width: 60mm

PP-2126 NEW $14.95

Also available
12V/24VDC Cigarette Lighter Socket Splitter
PP-2130 NEW $9.95
12V/24VDC Cigarette Lighter Socket Splitter Cable 1.2m
PP-2132 NEW $18.95

12V/24VDC Cigarette Lighter Socket Splitter with 2 x USB Ports

Powers two 12-24VDC accessories at the same time.

- USB output: 5VDC 2A (max)
- Overall width: 90mm

PP-2128 NEW $24.95

Also available
12V/24VDC Cigarette Lighter Socket Splitter Cable with 2 x USB Ports 1.2m
PP-2129 NEW $29.95

12V/24VDC Cigarette Lighter Socket 3 Way Splitter Cable

Powers three 12-24VDC accessories at the same time.

- Detachable mounting bracket with 3M adhesive
- Overall width: 90mm, Cable length: 1.2m

PP-2134 NEW $24.95

Also available
12V/24VDC Cigarette Lighter Socket 3 Way Splitter
PP-2135 NEW $14.95

Re-Wireable Trailer Connectors

A range of the most common 7 pin trailer plugs and sockets, featuring easy to use screw down terminals, corrosion resistant metal contacts and high quality UV stabilised plastics. See website for wiring guide.

7 Pin Flat Plug	PP-2050	$7.95
7 Pin Large Round Plug	PP-2052	$7.95
7 Pin Small Round Plug	PP-2054	$7.95
7 Pin Flat Socket	PS-2051	$7.95
7 Pin Large Round Socket	PS-2053	$7.95
7 Pin Small Round Socket	PS-2056	$7.95

NEW $7.95 EA

Tablet Holder with Heavy Duty Suction Mount

This holder will accommodate a variety of different sized Tablets for your car, truck, or van. Grip size can be widened easily by sliding them out of the grooves.

- Compatible with iPad®, Android, surface Tablets
- Size: 190(H) x 140(L) x 140(W)mm

HS-9036 NEW $29.95

Also available
Universal Smartphone/Tablet Holder with HD Suction Mount
HS-9034 NEW $24.95

Multimedia HDMI Travel Kit

An handy HDMI travel kit for connecting Tablets, Smartphones, cameras, or laptops to displays with HDMI ports. The kit consists of a standard 1.2m HDMI lead and two adaptors to convert one end of the lead to either a Mini HDMI or Micro HDMI plug. Includes a travel pouch for your lead and adaptors.

- 24K Gold plated connectors
- HDMI 1.4 compatible
- Resolution up to 4092 x 2160 pixels

WC-7746 NEW $24.95

Handsfree AUX Mic Lead for Smartphones

Features a highly sensitive microphone on a slim line 3.5mm stereo audio lead so you can listen to music on your car stereo or talk on your mobile. Zero setup required, simply plug in.

- Length: 1.2m

AA-2097 NEW $14.95

iPhone® not included

Trailer Plug Adaptor Leads

300mm in length, and 6 versions available to fix up any mismatch of the 7 Pin Flat, 7 Pin Large round and 7 Pin Small round trailer connectors. Remember, match the plug end of the adaptor to the socket on your car, and the socket end of these adaptors to the plug end on your trailer.

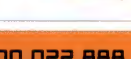
NEW $14.95 EA

7 Pin Flat Plug to 7 Pin Large Round Socket	PA-2061 $14.95
7 Pin Flat Plug to 7 Pin Small Round Socket	PA-2062 $14.95
7 Pin Small Round Plug to 7 Pin Flat Socket	PA-2063 $14.95
7 Pin Large Round Plug to 7 Pin Flat Socket	PA-2064 $14.95
7 Pin Small Round Plug to 7 Pin Large Round Socket	PA-2065 $14.95
7 Pin Large Round Plug to 7 Pin Small Round Socket	PA-2066 $14.95

7 Core Trailer Wiring Loom - 10m

A 10m length of the standard 7 conductors sheathed in a tough black PVC jacket. See website for wiring guide.

WH-3090 NEW $34.95



5 Core Trailer Cable - 10m

A 10m length of the standard 5 conductors sheathed in a tough black PVC jacket. See website for wiring guide.

WH-3091 NEW $24.95

Don't Get Fined!

Extremely strong suction mount joined to a tough flexible gooseneck. A wide variety of Smartphones will sit comfortably in the adjustable grip so you can access your phone while in your vehicle. The cradle can be rotated for portrait or landscape view.

- Size: 235(L) x 84(W)mm

HS-9030 NEW $19.95

Also available
Smartphone Bracket Cup Holder Mount HS-9032 NEW $24.95

8W 240V LED Light Globes

New additions to our extensive range of ViriBright LED light globes. They offer a brilliant lumen performance with wide, evenly spread light output across a 270° output angle, making them better than traditional light globes in many cases.

Warm White 500 Lumens Bayonet
SL-2230 NEW $22.95

Warm White 500 Lumens Screw
SL-2231 NEW $22.95

Natural White 650 Lumens Bayonet
SL-2232 NEW $22.95

Natural White 650 Lumens Screw
SL-2233 NEW $22.95

Also available 5W and 10W. See website for more details.

NEW $22.95 EA

To order call 1800 022 888

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/07/2013.

SOUND & VISION

Masthead Amplifiers for Digital TV

VHF/UHF Masthead Amp

A large chunk of the Australian TV broadcast spectrum is being reallocated for the next generation 4G/LTE mobile phone service, and this may cause issue with existing TV reception equipment. This new 35dB masthead amplifier from Kingray adds a switchable filter to protect against this. See our website for full specifications.

- Includes mains power supply
- VHF 44-230MHz, UHF 520-860MHz

LT-3251

NEW $99.95

12V Masthead Amp Power Injector

An easy solution to powering a masthead amp on a caravan, RV, camper trailer etc. It plugs into a cigarette lighter/12V power socket and feeds power for a masthead amplifier.

- Suitable with LT-3251 VHF/UHF masthead amplifier shown above

LT-3259

NEW $34.95

USB Charge/Sync Leads for iPad®/iPhone®/iPod®

Suitable for Apple® iPhone®, iPod® and iPad® with 30-pin Apple® connector.

150mm Length
WC-7689 $4.95
3m Length
WC-7688 $9.95

NEW FROM $4.95

Inserts for Keystone Wallplates

A range of inserts to cater for computer and audio video applications.

NEW FROM $4.95

Right Angle USB 2.0 Socket Keystone Insert
PS-0795 $4.95 — PS-0795

Right Angle HDMI Socket Keystone Insert
PS-0796 $9.95 — PS-0796

HDMI Socket Flylead Keystone Insert
PS-0797 $12.95 — PS-0797

See in-store or online for range of Keystone Wallplates

Indoor Amplifier TV Splitters

Split and amplify your UHF, VHF or FM signals to 2 or 4 other units with these handy amplifier splitters. Features high gain and low noise to ensure your signal is of a high quality.

- Mains adaptor included

2 Way
- Size: 110(L) x 70(W) x 35(H)mm

LT-3282 $24.95

4 Way
- Size: 158(L) x 80(W) x 45(H)mm

LT-3284 $34.95

NEW FROM $24.95

2.4GHz Wireless Amplifier System

Send crystal clear audio from your Hi-Fi or portable music device to speakers up to 20m away without messy wiring. Connect your speakers to the spring terminals and power using the included power supplies or by batteries. Supplied with 2 x 150mm 3.5mm curly cables to connect your audio source.

- Power output: 15WRMS x 2 (into 4 ohms)
- Transmitter and receiver requires 8 x AA batteries each
- Size (transmitter and receiver): 156(L) x 45(H) x 95(W)mm

AR-1895 ***was $129.00***

Limited Stock. Hurry!

$99.00 SAVE $30

6-in-1 Universal Remote Control

Manage a database of IR codes on the computer, not from the remote control. Use the provided software for easy setup or to individually assign a function to each button. Regular updates to the database ensure compatibility with the latest TVs, DVD players, etc.

- Advanced learning functions
- Up to 4 macro buttons
- Requires 3 x AAA batteries
- Size: 190(H) x 48(W) x 20(D)mm

AR-1719

NEW $29.95

Turn your Home Theatre Wireless

Add Wi-Fi to your array of home entertainment devices. For those with Ethernet only Smart TVs, game consoles, Blu-Ray player this device will allow you to make them ali wireless so you don't have to run long cables all over the house to your internet connected Wi-Fi modem.

- Size: 127(W) x 30(H) x 96(D)mm

YN-8361

NEW $59.95

Amplified HDMI Leads

Achieve longer HDMI cable runs with these amplified leads. They boost the signal strength with a built-in equaliser enabled lengths from 10-20m without the use of a power supply.

- HDMI High Speed with Ethernet
- HDMI 1.4 Compatible

10m WQ-7430 $79.95
15m WQ-7432 $99.00
20m WQ-7434 $129.00

NEW FROM $79.95

UHF/VHF Digital TV Masthead Amplifier

Connect a separate UHF & VHF, or a combination UHF/VHF antenna to this amplifier for excellent signal amplification. Suitable for analogue, digital, and HDTV signals.

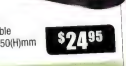
- Supplied with AC power injector and F-type to PAL adaptors
- Input gain: UHF 26dB, VHF 18dB
- Size: 125(W) x 102(H) x 45(D)mm

LT-3275

NEW $49.95

USB Portable Speaker

Connects to MP3 players, Smartphones, computers or any other audio source to play your favourite tunes with great sound quality.



- Rechargeable
- Maximum power: 12W
- MAC® and PC compatible
- Size: 210(L) x 60(W) x 50(H)mm

XC-5197

$24.95

9 Band Pocket Radio

A powerful little radio capable of receiving FM/MW/SW1-7 bands. Features full clock functions, an alarm, antenna, and a 3.5mm headphone jack for personal listening.

- Requires: 2 x AA batteries or 3VDC plugpack
- Size: 110(L) x 70(H) x 24(D)mm

AR-1736

NEW $24.95

AM/FM/SW Rechargeable Radio with MP3

A tri-band compact, portable AM/FM/SW radio with built-in MP3 player and digital clock. Supports USB flash drive and microSD card (32GB max).

- 3.5mm headphone jack
- Built-in high quality rechargeable Li-Ion battery
- USB cable included
- Size: 114(L) x 70(H) x 25(D)mm

AR-1721

NEW $29.95

AM/FM/SW/LW/AIR PLL Radio with SSB

Feature-packed radio with the added function of single-sideband modulation (SSB). SSB is used to obtain current weather reports, so it is perfect to take to sea to avoid changing weather conditions. Mains adaptor included and can be battery operated. See website for full specs.

- Size: 310(W) x 195(H) x 100(D)mm

AR-1945

NEW $179.00

Jaycar ELECTRONICS
Better. More Technical.

ARDUINO DEVELOPMENT KITS

Arduino-Compatible Boards

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs (includes Jaycar stepper motors). Arduino projects can be stand-alone, or they can be communicated with software running on your computer. These Arduino development kits are 100% Arduino-compatible. Designed in Australia and supported with tutorials, guides, a forum and more. A very active worldwide community and resources are available with many projects, ideas and programs available to freely use. Learn more at www.jaycar.com.au/arduino

LeoStick, Arduino Compatible

A tiny Arduino-compatible board that's so small you can plug it straight into your USB port without requiring a cable! Features a full range of analogue and digital I/O, a user-controllable RGB LED on the board and an onboard Piezo/sound generator.

- ATmega32u4 MCU with 2.5K RAM and 32K Flash
- Size: 49(W) x 19(H) x 8(D)mm

XC-4266 **$29.95**

Also available
LeoStick Prototyping Shield XC-4268 $7.95

EtherTen, Arduino Compatible with Onboard Ethernet

Includes onboard Ethernet, a USB-serial converter, a microSD card slot for storing gigabytes of web server content or data, and even Power-over-Ethernet support.

- ATmega328P MCU running at 16MHz
- 10/100base-T Ethernet built in
- Used as a web server, remote monitoring and control, home automation projects
- 8 analogue inputs
- Size: 76(W) x 54(D) x 19(H)mm

XC-4216 **$69.95**

EtherMega, Mega Sized Arduino Compatible with Ethernet

The ultimate network-connected Arduino-compatible board: combining an ATmega2560 MCU, onboard Ethernet, a USB-serial converter, a microSD card slot for storing gigabytes of web server content or data, Powerover- Ethernet support, and even an onboard switchmode voltage regulator so it can run on up to 28VDC without overheating.

- 10/100base-T Ethernet built in
- 54 digital I/O lines
- 16 analogue inputs
- microSD memory card slot
- Prototyping area
- Size: 105(W) x 54(H) x 19(D)mm

XC-4256 **$119.00**

Also available
Mega Prototyping Shield for Arduino to suit
XC-4257 $17.95

ARDUINO Shields

Shields are expansion boards that plug into the top of your Arduino to extend its capabilities. Available shields include displays and keypads, radio link receivers, communications, meter and relay drivers, etc. See online or in-store for our complete range.

ProtoShield Short

A dedicated short version prototyping shield for EtherTen (XC-4216) and EtherMega (XC-4256). This special prototyping shield is designed to fit neatly behind the RJ45 Ethernet jack, allowing you to stack your Ethernet-based projects right on top with standard headers.

- Gold-plated surface
- Size: 49(L) x 54(W) x 2(D)mm

XC-4248 **$4.95**

ProtoShield Basic

A prototyping shield for the Eleven (XC-4210) and USBDroid (XC-4222). Provides plenty of space to add parts to suit any project, keeping everything neat and self-contained. Includes dedicated space to fit a power LED and supply decoupling capacitor.

- Gold-plated surface
- Size: 59(L) x 53(W)mm

XC-4214 **$4.45**

433MHz Receiver Shield

This receiver shield lets you intercept 433Mhz OOK/ASK signals, decoding them in software on your Arduino. All the Arduino headers are broken out to solder pads, and GND and 5V rails are provided for convenience.

- Reset button
- Red and green user-defined LEDs
- Gold-plated surface
- 433.92Mhz tuned frequency
- Size: 60(L) x 54(W) x 9(D)mm

XC-4220 **$29.95**

8 Channel Relay Driver Shield

Drive up to 8 relays from an Arduino using just 2 I/O pins. It communicates with your board using I2C, so you can even stack several shields together to drive 16, 24, or more outputs!

- Size: 52(W) x 66(H) x 12(D)mm

XC-4276 **$34.95**

Also available
4 Channel Relay Driver Module for Arduino XC-4278 $13.95

H-Bridge Motor Driver Shield for Arduino

Directly drive DC motors using your Arduino compatible board and this shield, which provides PWM (Pulse-Width Modulation) motor output on 2 H-bridge channels to let your board control the speed, direction and power of two motors independently. Perfect for robotics and motor control projects.

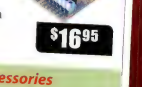
NEW
- Drives up to 2A per motor channel
- Size: 60(L) x 54(W) x 12(D)mm

XC-4264 **$29.95**

DUE MID JULY

Terminal Shield for Arduino

A special prototyping shield for Eleven (XC-4210) and USBDroid (XC-4222) that provides handy screw terminals on both edges for easy and secure connection.



- Gold-plated surface
- Large prototyping area
- Size: 79(L) x 61(W) x 26(D)mm

XC-4224 **$16.95**

Eleven, Arduino Uno Compatible

An incredibly versatile programmable board for creating projects. Easily programmed using the free Arduino IDE development environment, and can be connected into your project using a variety of analogue and digital inputs and outputs. Accepts expansion shields and can be interfaced with our wide range of sensor, actuator, light, and sound modules.

- 8 analogue inputs

XC-4210 **$39.95**

Prototyping Accessories

Stackable Header Set for Arduino

The perfect accessory to the ProtoShield Basic, Pro, and vero type boards when connecting to your Arduino compatible project.

- Gold flash 0.1" pitch quality stackable headers
- 2 x 8 pin and 2 x 6 pin included to suit the Eleven, EtherTen, USBDroid and ProtoShields

HM-3207 **$2.95**

Breadboard

- 1680 tie points
- 400 distribution holes
- 1280 terminal holes
- Mounted on a metal plate
- Board size: 130(W) x 175(H)mm

PB-8816 **$39.95**

FREE Jumper Kit (WH-3032) worth $3.45 with every purchase

To order call 1800 022 888

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/07/2013.

SIMPLE TO ADVANCED PROJECTS

ARDUINO Books

Programming Arduino: Getting Started with Sketches

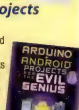
This entry level book explains what an Arduino microcontroller actually is, introduces you to the Arduino programming language and then describes the basic configurations of Arduino modules. It goes then into the detail and finishing with a discussion on C++ and more sophisticated applications.

- Soft cover, 162 pages
- 138 x 215mm

BM-7133 NEW $17.95

Arduino + Android Projects for the Evil Genius

A project oriented book written around Android-type mobile phones and the Arduino microcontroller. Many projects use both the Arduino and the Android culminating in the creation of a home Automation system.



- Soft cover, 197 pages
- 215 x 275mm

BM-7135 NEW $34.95

Arduino Robot Builder's Bonanza

This book guides you through the construction of 7 robots that roll, walk, talk, slither and even sling insults at you. All projects feature the Arduino microcontroller platform.

- Soft cover, 464 pages

BM-7136 NEW $36.95

Power Regulator 28V (Switchmode) for Arduino

This regulator is a high tech switchmode supply with a selectable 5V or 7VDC output. The input voltage range of 6 to 28VDC is very flexible and it will not overheat at higher input voltages like the 7805 and other linear regulators may.

- Can also be used for the EtherTen and EtherMega Power-over- Ethernet for efficient switchmode supply remote powering
- Size: 21(W) x 33(H) x 6(D)mm

XC-4258 $19.95

Power-over-Ethernet Regulator

This regulator module fits onto the EtherTen (XC-4216) or EtherMega (XC-4256) to make them compatible with commercial 48V Power-over-Ethernet switches. It includes built-in smarts to communicate with the switch and negotiate a power rating for the device, then uses a switch-mode regulator to efficiently drop the 48V supplied via the LAN cable down to 7.5V for use by the Arduino compatible board.

- Implements the official 802.3af Power-over-Ethernet standard
- 12.5W maximum power rating
- Size: 31(W) x 33(H) x 12(D)mm

XC-4252 $29.95

ARDUINO Modules

The many modules available give you easy connections with online guides for interactive sensors, actuators, displays, light and sound.

Hall Effect Magnetic & Proximity Sensor Module

Sense magnetic presence, rotating wheels and magnets, door and arm sensors, and anything else magnetic nearby this sensor.

- Green "triggered" LED for easy setup and use
- Output turns on at 40 Gauss (4mT) and turns off at 30 Gauss (3mT)
- Size: 21(W) x 16(H) x 4(D)mm

XC-4242 $9.95

Sound & Buzzer Module

This versatile piezo-element module can be used for both input or output! Also used as a noise-maker driven by your microcontroller for audible feedback of events, and as a knock-detector input to sense events and react to them. Includes a built-in 1M resistor to allow the piezo element to detect shocks.

- Frequency response 0-20KHz, peak resonant frequency: 4KHz +/-500Hz
- Sound pressure level at 10cm: 75dB (min)
- Size: 23(W) x 16(H) x 5(D)mm

XC-4232 $9.95

Microphone Sound Input Module

Give your project ears with this sound response and sound pressure level sensing module. An integrated dual signal amplifier converts the sound to separate channels for pulse and frequency measurement, and sound volume level. Designed to connect straight to an Arduino compatible, microcontroller analogue to digital converter or many other circuits.

- Omnidirectional microphone
- Size: 23(W) x 16(H) x 8(D)mm

XC-4236 $9.95

Logic Level Converter Module

This module easily connects different logic voltage levels together for bi-directional communication on up to 4 channels, allowing you to use low-voltage sensors with a 5V microcontroller.

- 4 bi-directional channels
- Size: 18(W) x 16(H) x 4(D)mm

XC-4238 $6.95

Shift Register Expansion Module for Arduino

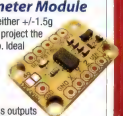
Use this shift register expansion module to drive up to 8 devices using just 3 pins on your microcontroller. They can also be daisy-chained together to drive 16 channels or more.

- 2 to 6V operation
- Size: 23(W) x 16(H) x 4(D)mm

XC-4240 $6.95

3-Axis Accelerometer Module

This module can operate in either +/-1.5g or +/-6g ranges, giving your project the ability to tell which way is up. Ideal for robotics projects, tilt sensors, vehicle dataloggers etc. Perfectly suited for Arduino projects.



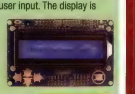
- Independent X, Y, and Z axis outputs
- Can run from either 5V or 3.3V
- Size: 23(W) x 15(H) x 4(D)mm

XC-4226 $19.95

ARDUINO Displays

16 x 2 LCD Shield for Arduino

Handy 16-character by 2-line display ready to plug straight in to your Arduino, with a software-controllable backlight and 5 buttons for user input. The display is set behind the shield for a low profile appearance and it includes panel mounting screw holes in the corners.



- 2 rows of 16 characters
- Software-controlled backlight
- Size: 85(L) x 53(W) x 23(D)mm

XC-4218 $29.95

Large Dot Matrix LED Display Panel - Blue

A huge dot matrix LED panel to connect to your Freetronics Eleven, EtherTen and more! This large, bright 512 LED matrix panel has on-board controller circuitry designed to make it easy to use straight from your board. Clocks, status displays, graphics readouts and all kinds of impressive display projects are ready to create with this display's features.

- 32 x 16 high brightness Blue LEDs (512 LEDs total) on a 10mm pitch
- 5V operation
- Viewable over 12 metres away
- Tough plastic frame
- Size: 320(W) x 160(H) x 14(D)mm

XC-4251 NEW $89.95

Can for comparison only

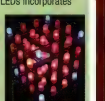
Also available

Large Dot Matrix LED Display Panel - Red

XC-4250 $39.95

RGB LED Cube Kit for Arduino

This stunning 3D-matrix of 64 RGB LEDs incorporates an onboard Arduino-compatible controller so you can produce mesmerising light shows controlled by software. Use it as a mood light or create your own "ambient device" that gently notifies you of new email or instant messages. Some assembly required.



- 4 x 4 x 4 matrix of individually addressable 8mm RGB LEDs
- Size: 106(W) x 130(H) x 106(D)mm (assembled)

XC-4274 $89.95

For ARDUINO Video and Projects visit

www.jaycar.com.au/arduino

Jaycar electronics — Better, More Technical

SECURITY PROJECTS

Budget Surveillance Package

Records video from the four day/night colour cameras constantly, scheduled or when motion is detected. Uses H.264 video compression to store up to 300 hours of video on its 500GB hard Drive. View live or played back video on a TV, computer monitor or access over the Internet using a standard web browser or Smartphone/ iPhone® free app. Remote, mouse, 4 x 18m cables and power supply included. For full specs, see website.

- Backup to external USB drive
- Email motion detect alert
- Up to 704 x 576 pixel D1 resolution on each channel
- Includes 4 colour weatherproof CMOS 350 TV Line cameras QV-3028 ***was $499.00***

Also available:
DVR Package + 17" ASUS Colour Monitor
QV-3100 ***was $649.00 now $549.00 save $100.00***

Add this 17" Monitor for $150

$399.00 SAVE $100

Monitor also sold separately (QM-3577)

36 LED Signal Strobe Light with Magnetic Base

A strobe light suitable for emergency situations. Includes 36 high brightness LEDs positioned behind orange lenses. Also features a strong magnetic base for mounting to cars or boats. 0-ring sealed.

- Requires 2 x D batteries
- Size: 146(H) x 114(Dia.)mm ST-3234

NEW **$39.95**

Eye Glasses with 720p HD Camera

Hollywood Director style glasses that hide a secret 720p digital video recorder with 8GB memory. Camera lens is located on the nose bridge and is difficult to see. Powered by rechargeable batteries via USB.

- Video format: AVI
- Video Resolution: Up to 1280 x 720
- Photo Resolution: 1600 x 1200
  QC-8022

Warning: These cameras should not be placed in areas where there is an expectation of privacy.

NEW **$179.00**

DIY IP Cameras

Designed for use with any common household router. Access through web browser or iPhone®/Android® app to see what is really going on while you're away. Features Wi-Fi and wired connectivity with easy setup and configuration options, and motion alarm detection which can email or FTP upload camera snapshots at a specified internal.

FROM **$89.00**

- MJPEG video compression
- 1/5" Colour CMOS Sensor, 300k Pixels
- IR LEDs for visibility in the dark
- Wireless transmission up to 50m

Wi-Fi Camera with IR LEDs
Our entry level DIY IP camera.

- Size: 140(H) X 105(W) X 95(D)mm
  QC-3832 $89.00

Pan/Tilt Camera with IR
Pan/tilt functionality so you can change the view angle as you please.

- Size: 125(H) x 100(W) x 95(L)mm
  QC-3834 $119.00

Outdoor Wired/Wi-Fi Camera
Designed for external use with tough aluminium housing.

- Size: 95(L) x 85(H) x 30(W)mm
  QC-3836 $149.00

Tracking Devices

Wireless Luggage Tracker

Track the location of your luggage by attaching the switched on slave unit to your bag prior to check-in. Doubles as an anti-theft device for a wallet, purse etc. Just place the credit card sized slave unit into your wallet or purse, set the desired distance to either six or fifteen metres, and keep the master unit in a different spot such as in your pocket.

- Up to 120m range (line of sight)
- Alarm with vibration
- Belt clip included
- Master size: 52.8(L) x 39(W) x 13.2(D)mm
  Slave size: 80(L) x 50(W) x 2.8(D)mm
  XC-0360 ***was $39.95***

$29.95 SAVE $10

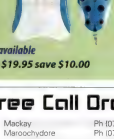
Wireless Child Tracker - 4 Channel

Be alerted when your child has wandered away! Simply place the small lightweight transmitter in the child's pocket, bag or by using the included lanyard. Features include panic button, and a search function with direction and distance indication. Also use with pets, mobile phones, and other valuables.

- Can support up to four transmitters
- 2.4GHz digital RF technology
- Receiver size: 95(L) x 65(W) x 18(D)mm
- Transmitter size: 61(L) x 36(W) x 11(D)mm
  XC-0362 ***was $49.95***

Additional transmitter tags available
XC-0363 ***was $29.95 now $19.95 save $10.00***

$39.95 SAVE $10



Personal GPS/GSM Tracking Device

Locate a personal belonging using your phone. To operate insert a GSM sim card (not included), charge and complete the initial setup. Send an SMS to the locator from your phone and it will return an SMS with GPS coordinates or a link to Google Maps if you are using a Smartphone. See website for more features.

- Rechargeable and compact
- USB cable and in-car charger included
- Operates for up to 3 days between charges
- Size: 61(L) x 42(W) x 11(D)mm LA-9013

$149.00

YOUR LOCAL JAYCAR STORE – Free Call Orders: 1800 022 888

• AUSTRALIAN CAPITAL TERRITORY

Belconnen Ph (02) 6253 5700
Fyshwick Ph (02) 6239 1801

• NEW SOUTH WALES

Albury Ph (02) 6021 6788
Alexandria Ph (02) 9699 4699
Bankstown Ph (02) 9709 2629
Blacktown Ph (02) 9678 9669
Bondi Junction Ph (02) 9369 3699
Brookvale Ph (02) 9905 4130
Campbelltown WE HAVE MOVED Ph (02) 4620 7155
Castle Hill Ph (02) 9634 4470
Coffs Harbour Ph (02) 6651 5238
Croydon Ph (02) 9799 0402
Erina Ph (02) 4365 3433
Gore Hill Ph (02) 9439 4799
Hornsby Ph (02) 9476 6221
Liverpool Ph (02) 9821 3100
Maitland Ph (02) 4934 4911
Newcastle Ph (02) 4965 3799
Penrith Ph (02) 4721 8337
Port Macquarie Ph (02) 6581 4476
Rydalmere Ph (02) 8832 3120
Sydney City Ph (02) 9267 1614
Taren Point Ph (02) 9531 7033
Tuggerah NEW Ph (02) 4353 5016
Tweed Heads WE HAVE MOVED Ph (07) 5524 6566
Wagga Wagga Ph (02) 6931 9333
Warners Bay NEW Ph (02) 4954 8100
Wollongong Ph (02) 4226 7089

• NORTHERN TERRITORY

Darwin Ph (08) 8948 4043

• QUEENSLAND

Aspley Ph (07) 3863 0099
Browns Plains NEW Ph (07) 3800 0877
Caboolture Ph (07) 5432 3152
Cairns Ph (07) 4041 6747
Caloundra NEW Ph (07) 5491 1000
Capalaba Ph (07) 3245 2014
Ipswich Ph (07) 3282 5800
Labrador Ph (07) 5537 4295
Mackay Ph (07) 4953 0611
Maroochydore Ph (07) 5479 3511
Mermaid Beach Ph (07) 5526 6722
Nth Rockhampton Ph (07) 4926 4155
Townsville NEW Ph (07) 4772 5022
Strathpine Ph (07) 3889 6910
Underwood WE HAVE MOVED Ph (07) 3841 4888
Woolloongabba Ph (07) 3393 0777

• SOUTH AUSTRALIA

Adelaide Ph (08) 8231 7355
Clovelly Park Ph (08) 8276 6901
Elizabeth NEW Ph (08) 8255 6999
Gepps Cross Ph (08) 8260 2500
Reynella Ph (08) 8387 3847

• TASMANIA

Hobart Ph (03) 6272 9955
Launceston Ph (03) 6334 2777

• VICTORIA

Cheltenham Ph (03) 9585 5011
Coburg Ph (03) 9384 1811
Ferntree Gully NEW Ph (03) 9758 5500
Frankston Ph (03) 9781 4100
Geelong Ph (03) 5221 5800
Hallam Ph (03) 9796 4577
Kew East Ph (03) 9859 6188
Melbourne Ph (03) 9663 2030
Ringwood Ph (03) 9870 9053
Shepparton Ph (03) 5822 4037
Springvale Ph (03) 9547 1022
Sunshine Ph (03) 9310 8066
Thornastown Ph (03) 9465 3333
Werribee Ph (03) 9741 8951

• WESTERN AUSTRALIA

Joondalup Ph (08) 9301 0916
Maddington Ph (08) 9493 4300
Mandurah NEW Ph (08) 9586 3827
Midland Ph (08) 9250 8200
Northbridge Ph (08) 9328 8252
Rockingham WE HAVE MOVED Ph (08) 9592 8000

Arrival dates of new products in this flyer were confirmed at the time of print but delays sometimes occur. Please ring your local store to check stock details.
Prices valid from 24th June 2013 to 23rd July 2013.

Occasionally there are discontinued items advertised on a special / lower price in this promotional flyer that has limited to nil stock in certain stores, including Jaycar Authorised Stockist. These stores may not have stock of these items and can not order or transfer stock.

HEAD OFFICE
320 Victoria Road, Rydalmere NSW 2116
Ph: (02) 8832 3100 Fax: (02) 8832 3169

ONLINE ORDERS
Website: www.jaycar.com.au
Email: techstore@jaycar.com.au

Jaycar electronics — Better, More Technical

SERVICEMAN'S LOG

Smoke: it's not always a bad thing

Dave Thompson*

Smoke wafting from an electronic device is usually not the most welcome sight in any serviceman's lair. But there's often a silver lining. Its presence can make diagnosing whatever problem ails the device a lot easier.

Items Covered This Month

- Smoking laptop computer
- Smoking power supply
- Faulty PC power supply
- The buzzing PA system
- Hung Chang scope repair
- Nissan Patrol fuel-gauge problem
- Faulty infusion pumps

SMOKE FROM any electronic device is always a cause for concern. However, if it helps in tracking down a problem, then I'm all for taking advantage of an otherwise bad situation.

Over the years, I've had some interesting smoke moments and while some are spectacular (and entertaining), all are serious because smoke usually indicates major problems. In particular, the heat associated with the smoke can cause even more damage than the original component failure, sometimes to the point where the device is beyond economic repair.

In a recent case, a client brought a supposedly dead laptop in to my workshop. This machine would power on but only for a very brief period.

A TINY WISP OF SMOKE CURLED OUT FROM NEAR THE SCREEN'S HINGE MOULDING

When the power button was pressed, the idiot lights would flash once and then go out. After that, there would be no further signs of life.

The usual procedure in a case like this is to first use a multimeter to check that the external power supply is delivering the correct voltages. I then go on to try various combinations of the battery and power supply to make sure the battery isn't shorted internally or dead flat, or that the power supply itself isn't faulty under load, all of which can cause similar symptoms.

Anyway, I was carrying out this procedure in front of the client (as part of our booking-in procedure) when she suddenly pointed to the lefthand screen hinge area and exclaimed "smoke"! I had also seen it out of the corner of my eye and immediately disconnected the power supply before flipping the machine over to eject the battery.

After disconnecting all the power sources, the smoke stopped but our noses told us all we needed to know. That familiar acrid smell meant that something had really heated up enough inside the laptop to cause some real damage. And that almost certainly meant dead parts and perhaps a scorched circuit board and/or damage to cable insulation.

The area the smoke came from was adjacent to the power button, which is on the top lefthand side of the laptop and adjacent to where the power supply plugs in. This naturally had me thinking that the problem was centred there, so that's the first place I looked.

On this laptop, a 25mm-wide plastic strip (or panel) runs the width of the machine adjacent to the screen and this houses various indicator lights and the power and WiFi on/off buttons. This panel is held on with both plastic clips and two screws on the underside of the computer, the latter sneakily hidden in the battery compartment.

This arrangement is a trap for many younger players who struggle to take off these panels. On most machines, the plastic clips are notoriously tough to undo without breaking, especially if they've never been off before. What's more, if no screws are visible after a quick inspection of the underside, it's easy to assume that these clips are all that hold the panel in place. This further increases the risk of breaking the clips if an attempt is then made to prise the panel off.

So it always pays to look for any screw fasteners that may be tucked away under the battery or any of the various removable covers found underneath many laptops.

I've even seen screws hidden behind removable memory or WiFi modules, as well as under product stickers or rubber bumpers. Breaking a panel getting it off can really ruin your day, especially since many manufacturers don't offer them as spare parts. So unless you happen to have an identical dead laptop lying around that you can steal panels from, you are unlikely to find another one to replace it.

Joining a broken panel with glue or plastic welding is also a non-starter because no matter how well it's done, it

Serviceman's Log – *continued*

WAFTING SMOKE SIGNIFIES A SILVER LINING IN THE SERVICEMAN'S LAIR...

just looks awful and the client is likely to be very unhappy. If in doubt, the internet usually has well put-together guides on stripping down just about anything. At the very least, there will be a service manual for your model somewhere on-line that you can refer to.

Of course, most males really don't like reading any form of instructions. However, I like eating crow sandwiches and apologising to clients for ruining their thousand-dollar machines even less. As a result, I always Google the exact model number of the machine and add either "manual", "user guide" or "disassembly" to the search criteria.

Too much information

Of course, the big problem with internet searches is that there are typically hundreds (if not thousands) of results returned, even when very specific search criteria are used. Sorting through these can be a real headache and can be very time consuming.

One strategy I use is to do an image search instead of the usual web search. The number of image search results is usually a lot more manageable, not only because there are less of them to sort through but also because you can quickly browse through the resulting thumbnails to locate the manual or reference material you want.

Another tip is to use the video search function. Given that everyone wants to have their 15 minutes of video fame these days, chances are someone out in cyberspace has recorded and uploaded a "walkthrough" or instructional video for your particular device to YouTube.

Back to the laptop

Getting back to my client's smoking laptop, I've serviced dozens of this particular model so I knew all about the screws under the battery and soon had the panel off in one piece. It all looked fine under there though, with no signs of burning or soot deposits or charred circuit boards anywhere. Even the smell had now faded away to the point where I could barely detect it, even with my nose pressed right against the affected area.

At this stage, I had two choices: (1) I could spend time stripping the rest of the machine down in the hope that I would see something obvious, or (2) I could reconnect the power supply, push the power button and let the smoke guide me directly to the problem. In this case, I decided that the latter approach would be the best way forward, so I reconnected the power supply and the power button assembly (which I'd removed from the panel I'd just taken off).

Before switching on though, I sat my trusty fire extinguisher near the workbench – not because I seriously thought I'd need it but because it's always better to be safe than sorry. As it turned out, I was being overly melodramatic. Almost as soon as I hit and held down the power button, a tiny wisp of smoke curled out from near the screen's hinge moulding, quite away from the power button area. It didn't seem to get any worse so I kept the power on for another few seconds.

I then quickly felt along nearby surfaces with a light finger touch and it didn't take long to pinpoint the source of the heat. The inverter for the screen's backlighting was almost too hot to touch despite only being powered up for a few seconds. So this was almost certainly the source of our smoke.

In most older laptops, the inverter usually lies sandwiched between the front and back screen surrounds, typically below the screen and between the hinges. Its job is to bump up the system voltage (usually 12V) to the level required to power the fluorescent backlighting found in older laptops.

These days, of course, the LCD panels used in laptops (and other devices) use LED backlighting but there are still lots of laptops out there with the older fluorescent system. You have to be very careful when working with these because the inverter can give you quite a nasty bite if you get near the "hot" (high-voltage) end while it is in operation.

Most laptop inverters consist of a

Servicing Stories Wanted

Do you have any good servicing stories that you would like to share in The Serviceman column? If so, why not send those stories in to us?

We pay for all contributions published but please note that your material must be original. Send your contribution by email to: editor@siliconchip.com.au

Please be sure to include your full name and address details.

few discrete components and some miniature transformers mounted on a PCB strip about 70mm long and 10mm wide. A multi-pin connector indicates the input, while a heavier-duty 2-pin connector feeds the high-voltage (HV) output to one or more fluorescent tubes which provide the backlighting. These fluorescent tubes are typically about 4mm in diameter and run the length of the LCD screen to be illuminated.

While these tubes eventually wear out (as with other fluorescent tubes) and go dim, the inverters don't often fail. However, when they do, they usually go open circuit, typically giving a dark screen with the desktop (or other images) faintly visible when the screen is viewed from certain angles.

In this case though, the inverter had shorted internally and this was locking the whole machine down and preventing it from powering up. Once I unplugged the inverter's input connector, the laptop booted happily and the video side of things worked fine with an external monitor connected to the VGA port.

The repair itself was straightforward. I sourced a new inverter and soon had the built-in screen up and running again, all at relatively low cost. So in this case, the smoke led me to the troublesome part, though it was fortunate the power didn't stay on for too long. It really wouldn't have taken much more for the heat from the shorted inverter to start deforming the screen frame and that would have been difficult, if not impossible, to replace.

Smokin' power supply

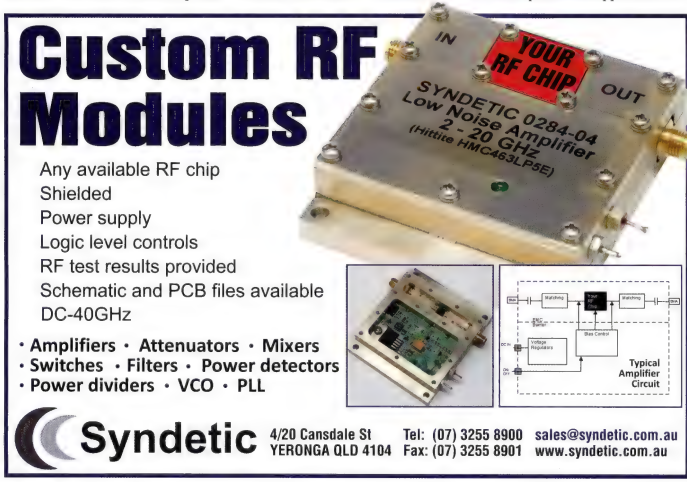
Another instance of smoke showing the way occurred when I was trying to resurrect a bench power supply for a friend. This was a very old home-built supply and given its state and the low cost of commercial workshop supplies these days, I recommended that he simply chuck it out and buy a new one. However, like many jobs that come my way, this unit had sentimental value and this overrode any sensible decision on his part regarding the likely cost of repair.

The first thing I noticed when I powered it up was zero output on the meter and smoke coming from the vents in the case. Undoing four self-tapping screws allowed me to remove the top section of the case and I soon spotted a rather discoloured 1W resistor, complete with blackened soot highlights, on the main PCB.

While I didn't really need any smoke to tell me where the problem lay, I nevertheless decided to turn the power on and watch the resistor light up. After confirming that this was indeed the source of the smoke, I disconnected the mains and discharged the filter capacitors. I then lifted the circuit board so I could see underneath and noted that a section of the copper track leading to this resistor had bubbled and lifted. So something was definitely loading things up too much.

This supply utilised two 2N3055 TO3-style transistors mounted on the chassis-cum-heatsink and I suspected that one or both of these might be the cause of the problem. There really wasn't much else in there to fail, so I cut to the chase and lifted the leads from both transistors. My trusty transistor tester told me that one was a dead short while the other seemed OK.

I had two new 2N3055s in my parts drawer, so I replaced them both, treating them to new mica washers and a nice dab of heatsink compound as well. I then replaced the burnt resistor and repaired the copper track with



Nissan Patrol Fuel Gauge Problem

This next story is from P. E., of Heathcote, Victoria who recently ran into problems with the fuel gauge in his Nissan Patrol 4WD. Here's how he tackled what initially seemed like an easy fix . . .

My Nissan Patrol is nearly 16 years young and has done a lot of work on very rough outback roads. It has both an after-market main fuel tank and an auxiliary tank, so there is little room for fuel hoses and the like to be routed.

After recently filling both tanks with "cheap" fuel in Melbourne, I subsequently noticed on the way home that the fuel gauge was reading empty. Well, what could be easier? – it could only be the gauge, the sender unit or the wiring between them, so tracking down the fault should be straightforward – especially as I also had a complete workshop manual for the vehicle.

I began by removing the instrument cluster and bench testing it as detailed in the manual. It checked out OK, so I next accessed the top of the sender unit to test the wire (yellow/black) that ran to fuel gauge. It too checked out and so, as I feared, it had to be the sender unit.

I removed the sender and a close inspection revealed that the small fuel return pipe had broken off, taking a yellow wire with it. It also has a sensor at the bottom for the low-fuel light.

Using a torch, I could see the pipe on the bottom of the main tank, so I dipped my hand in to retrieve it. All I had to do now was weld the pipe back on, resolder the wire to the underside of the sender, reassemble everything and the job would be done – or so I thought.

However, I couldn't understand how the low-fuel sensor had any relevance to the fuel gauge. The sender unit has three external wires: the earth is the black wire; the float-controlled potentiometer wiper is yellow on the outside of the sender unit and pink on the inside but goes to yellow/black on the loom; and the low-fuel sensor is yellow/blue on the outside and yellow on the inside! Why do car manufactures add complexity to simple systems?

The pot varies from 5Ω when the tank is full to about 80Ω when it's empty. This bench-tested OK.

After making the necessary repairs, I decided to check that everything was working correctly before reinstalling the sensor. To my surprise, the fuel gauge still read empty so what was going on?

In the end, I concluded that it had to be a fault in the wiring, even though I had already tested this. So back to basics – I unplugged the sender unit from the car and as I did so, the socket separated from the loom. The four wires had all been "rubbed-through" and severed where they ran between two rubber hoses. Splicing in new wiring fixed the problem and I also re-routed the loom to prevent a re-occurrence.

When I first tested the loom, the wires must have all made sufficient contact when I moved the socket to give good readings. And the broken pipe? – who knows how long I've been without a low-fuel light. I never did find out why there are four wires in the loom when the sender has three.

some hook-up wire and powered it up.

The voltage adjustment pot was a bit dodgy and needed a squirt of cleaner but other than that, it all worked well and there was no more smoke!

Faulty PC power supply

Sometimes, all you have to do is use your eyes to track down a faulty part. It certainly paid off for J. W. of Bairnsdale, Vic . . .

The Serviceman's Log of March 2013 titled "PC Power Supplies: Not Worth Fixing", prompted me to finally write this story. It may be significant for the fact that the dreaded Murphy seems to have been on holiday throughout the entire repair process.

Some time ago, my sister's computer (tower case) developed an annoying habit of shutting down without warning. This was not as simple as the screen-saver turning on or her accidentally hitting the power switch. One second the computer would be running normally and the next it would be totally dead. There would be absolutely no warning; it would simply stop.

The fact that this was a real hardware fault and not a software problem was confirmed when it eventually became impossible to reboot the computer without first disconnecting and reconnecting the mains power cord from the computer. Eventually the problem became so bad that even this trick didn't always work.

With neither myself nor my sister having much in the way of spare cash at the time, and since I have some skill at electronic repairs, I realised that we had nothing to lose and decided to delve into the "forbidden territory" of the power supply.

The first thing I did on opening the case was carry out a careful visual inspection. This proved to be the right thing to do as I quickly noticed a definite case of "capacitor bulgitis", complete with a smear of "brown goop". Based on this evidence, I went straight to our local electronics shop and purchased a replacement capacitor.

With memories of warnings about charged high-voltage capacitors ringing in my head, I first used a heavy screwdriver to short out and discharge all the electrolytic capacitors I could find on the circuit board before going to work with the soldering iron. This precaution proved to be prudent as a few of the capacitors produced noticeable sparks.

But all that effort paid off. After reassembling everything and reconnecting the AC power, I pressed the power button and the computer started immediately. It subsequently continued to start and run without any problems until it was replaced with a newer model a couple of years later.

So for less than a tenth of the cost of a new power supply and with a little effort, I managed to extend the life of this computer by a couple of years. I consider that a reasonable exchange.

The buzzing PA system

A. H. of Evatt, ACT recently found an unusual fault that affected a PA

system. But it wasn't the PA system that caused the problem . . .

We received a call from our local shopping mall about a PA system that was making a horrible buzzing noise. However, before visiting the premises, I decided to try a little "over-the-phone" troubleshooting, to see if we could isolate the problem.

First, I told the client to turn down all the input controls (eg, for microphones, music etc) and check if the buzz was still there. The answer was "yes" so it appeared that the interference was probably not getting into the amplifier from an external signal source.

Step 2 was to get the client to turn down the master volume control on the amplifier and check again. Once again the buzz was still there which was puzzling but perhaps there was a fault in the power amplifier stage.

Step 3 was to ask the client to turn the amplifier off at the power point. The buzz was still there, so it looked like the PA system itself was not at fault. In fact, it wouldn't be the first time that a PA had been reported as buzzing when the fault was actually a noisy light fitting or fan.

When we arrived, there was no buzz to be heard so we turned the PA system on and checked it out. There was still no buzz, so we had a wander around and found that a row of speakers connected to the system were inoperative.

There was nothing for it but to retrieve a step ladder from the van and investigate the wiring in the ceiling. Fortunately, the mall used ceiling tiles so access was relatively easy.

What we discovered was a rat's nest of power cabling, PA cabling and telephone cabling. As a result, our only option was to physically trace the figure-8 cabling from the last speaker that worked until we found a cable fault.

We soon discovered that this cabling had dropped neatly across the edge of the spade terminal on a neon sign, where the insulating boot had not been correctly installed. And as luck would have it, it was the one supplying high voltage to the sign. The result was a very neat burn which had cut into and open-circuited one side of the figure-8 cable.

So there was a fault in the PA system (or at least in the wiring to a bank of speakers) but it was the neon sign that had caused the problem.

Hung Chang scope repair

Getting old oscilloscopes back into working order can be a real challenge. P. C. of Kambah, ACT recently pitted his wits against his ancient Hung Chang Model OS-620 oscilloscope which had developed a number of faults . . .

Amongst my collection of test gear, I have a secondhand Hung Chang Model OS-620 oscilloscope. It's old, being roughly 1970s vintage, but still quite useful.

I was using it recently to check out a car audio power amplifier and had the usual sinewave input displayed on one channel and the output across a dummy load displayed on the other. However, just as I got it all set up, the trace suddenly collapsed to a bright line about three quarters the width of the screen and tilted up slightly to the right.

A few quick checks revealed that none of the vertical axis controls had any effect on the trace and the brightness control had also ceased to function. However, the horizontal position control could move the trace about half way across the screen. As it was late afternoon, I decided the best course of action was to leave it for the time being and come back to it when I was fresh.

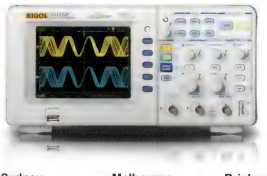
A day or two later, I took the covers off the scope and took a close look at the vertical amplifier board. The first thing I noticed was that the scope had received attention to the vertical amplifier area at some time in its past. You could tell that the vertical output transistors had been replaced and a few resistors had been soldered to the underside of the board that didn't look like original components.

At this stage, I powered the unit up and checked the main HT rail to the board. It was supposed to be +120V and it was reading +78V so obviously that wasn't right.

Next, I removed the vertical amplifier board from the chassis. This involved de-soldering a few connections to the front panel input sockets and AC/GND/DC switches and then unplugging a number of headers. It was then only necessary to remove four screws holding the board to the

Australia's Lowest Priced DSOs

Shop On-Line at emona.com.au



Now you've got no excuse ... update your old analogue scopes!

Whether you're a hobbyist, TAFE/University, workshop or service technician, the Rigol DS-1000E guarantee Australia's best price.

RIGOL DS-1052E 50MHz

- 50MHz Bandwidth, 2 Ch
- 1GS/s Real Time Sampling
- 512k Memory Per Channel
- USB Device & Host Support

ONLY $362 inc GST

RIGOL DS-1102E 100MHz

- 100MHz Bandwidth, 2 Ch
- 1GS/s Real Time Sampling
- 512k Memory Per Channel
- USB Device & Host Support

ONLY $439 inc GST

Sydney Tel 02 9519 3933 Fax 02 9550 1378
Melbourne Tel 03 9889 0427 Fax 03 9889 0715
email testinst@emona.com.au
Brisbane Tel 07 3275 2183 Fax 07 3275 2196
Adelaide Tel 08 8363 5733 Fax 08 8363 5799
Perth Tel 08 9361 4200 Fax 08 9361 4300
web www.emona.com.au

EMONA

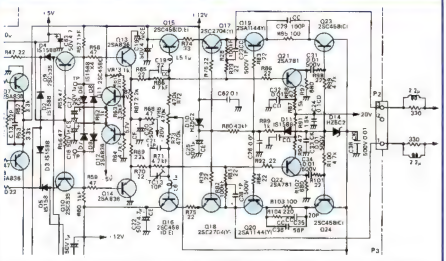


Fig.1: Hung Chang OS-620 vertical amplifier output stage. Several tranistors required replacement to get it working again.

frame and it was out. It was then that I discovered that the resistors fitted to the track side were bridging what had once been resistors on the component side. The latter were now charred little cylinders and obviously had been for some time (which is why the bridging resistors had been fitted).

The board itself (phenolic) was burned under one of the charred resistors and all things considered, it was not what I would consider a satisfactory repair. I also noticed that a couple of additional resistors showed clear signs of heat stress. As a result, I removed all the dead and wounded components and also the resistors hanging off the underside and cleaned up the scorched section of the board. All of these components were associated with the vertical amplifier output stage.

The output stage of the vertical amplifier (see Fig.1) has a circuit topology that's common to many other analog scopes and consists of cascode stages with a constant-current loads. In this case, Q15/Q17 and Q16/Q18 are the cascode stages, while Q19/Q23 and Q20/Q24 are the corresponding constant-current loads. Q21 and Q22 provide high-frequency boosting to extend the bandwidth of the amplifier.

Having identified the parts, I removed the main output transistors and their associated constant-current driver transistors. Each output transistor and its constant-current mate (TO-126 packages) are physically clamped together with two U-shaped aluminium heatsinks. Once free of the board and their heatsinks, it was easy to see that these transistors had been replaced at some stage as they were of a different type to those specified in the schematic. However, a quick check on the web showed that new types were reasonable substitutes for the originals.

A test of these components showed that two of them from one side of the output stage were a dead short (Q18 & Q20). So it was no wonder that the HT had been pulled low!

The original type specification was 2SC2704 for the cascode output and 2SA1144 for the constant current driver. I had no luck in finding an exact equivalent from the usual suppliers, so I opted for BF469s and BF470s. These types have a higher V_{CB} rating than the originals but a lower unity gain bandwidth of 80MHz. As the scope only has a 20MHz vertical bandwidth specification, I wasn't too concerned about this as I wouldn't be using this scope to chase fast pulses around digital circuits.

In due course, I fitted the new components and reinstalled the board but left the soldered connections to the input sockets and switches disconnected for the time being. I then powered up the scope and found that the traces looked much better and were now occupying the full width of the screen. The brightness control now also worked properly and I could now get two traces in dual mode. However, the vertical position controls could only shift them about three quarters of the way up the screen which meant that something else was still faulty.

I took a punt and checked the "top" transistors (Q23 & Q24) in the constant-current load circuit. Sure enough, one of them had failed – the one on the side of the other shorted transistors, or course (Q24)! These were 2SC458 types in a TO-92 package with an ECB lead arrangement but once again, I had no luck finding new replacements. However, these transistors are similar to the good old BC549 and I had plenty of those in my parts drawer.

Even though the complementary transistor in the other output leg was OK, it is always good practice to replace both in these situations. The BC549 has an EBC lead arrangement, so I crossed the leads of both transistors and fitted sleeving to the collector leads to reduce the likelihood of shorting. I then fitted them to the board and this time, the position controls worked as they should.

With this section now working correctly, I checked the HT rail and found that it was now at +153V. That was a bit too high for comfort, so I shut everything down again and checked the heatsinks on the output transistors. Ouch! – they were painfully hot! So it now looked like the power supply board needed attention.

A close inspection of this board showed that the HT regulator transistor had also been replaced at some stage. I removed this transistor and a check showed that it was shorted, so no regulation of the HT rail was taking place. This transistor too was not the original type but it was an acceptable equivalent.

Once again, I was unable to obtain the original type (or even one the same as the replacement) but a check of its specifications showed that a TIP32 should do the job. The series regulator transistor in this circuit is located in the negative (earthy) leg of the bridge rectifier and so is not subject to any great voltage stress. I fitted a new TIP32, reinstalled the power supply board and hit the switch. Everything came up as it should and I was able to adjust the HT rail to the specified value using the appropriate trimpot.

After that, I let the thing soak-test for five minutes or so and then shut it down again. This time the vertical output transistor heatsinks were just

barely warm, which was a good sign.

Now satisfied that all was working properly, I re-soldered the input connections to the vertical board, powered it up and hooked a probe on the calibration terminal. Both traces showed a nice square wave, so I switched it off again and refitted the covers.

The scope is now working normally but the academic question is this: did the HT regulator transistor fail first, thus raising the HT to a level that took out the vertical output transistors? Or did the latter fail first and knock out the regulator transistor due to excessive current?

I'll never know but at least I can get on with checking out that pesky audio amplifier.

Faulty infusion pumps

This column has recently featured stories about maintaining state-of-the-art medical equipment. K. D. of Chermside, Qld works at the other end of the spectrum, maintaining elderly and obsolete medical gear in research laboratories. Here's his story . . .

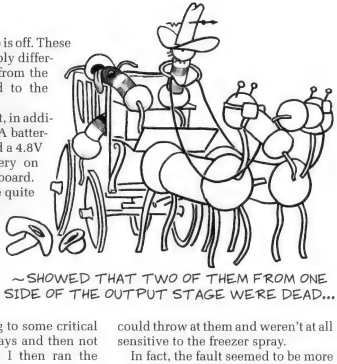
Unfortunately, a lot of older medical equipment is no longer supported by the manufacturers and the specialised parts and service tools are no longer available. This means that maintaining such equipment can be challenging and often requires novel mechanical and electronic solutions.

Just lately, I have been doing battle with two 15-year-old Gemini PC-4 infusion pumps, originally used in an intensive care unit (ICU) to deliver fluids and drugs to patients. In the laboratory, they had performed flawlessly, running over 30 hours a week. However, when switched on after the Christmas break, four of the eight channels across the two pumps gave error messages and wouldn't work.

The fault code related to the "air-in-line" detector, a system that uses ultrasound to differentiate between liquid and air in the pump tubing. However, I couldn't understand how half of these could have failed at once. The error code could also be associated with a mechanical system that detects if the pump has been dropped, so maybe "someone" had had an accident. I removed the covers but it was clear that the impact detectors hadn't tripped.

DC measurements of the "air-in-line" detector made no sense, so I probed the circuit with a scope. The circuit is driven by a series of pulses, even when the pump is off. These pulses were noticeably different when powered from the mains as compared to the batteries.

Then I noticed that, in addition to two large SLA batteries, these pumps had a 4.8V 70mAh NiMH battery on the power supply board. These batteries were quite old, so I replaced them "on-spec" while I had the pumps open. That cured the problems in both pumps and I put the faults down to the NiMH batteries discharging to some critical level over the holidays and then not accepting a charge. I then ran the pumps for several days and returned them to service.



My victory was short-lived because they subsequently both "bounced" on me; and it was a big bounce as they had more failed channels than before. Not only that but different channels had now failed.

I opened one pump and began comparing waveforms between a working and a failed channel. This led me to change a 2N4403 transistor which appeared to have marginally low gain. That channel then began working and I quietly cursed the designer for making a circuit so dependent on component specifications. I then switched on the second pump which showed three failed channels in the lab and had been sitting on the workshop floor while I worked on the first pump. It now gave no errors at all, so what was going on?

I had a long think and eventually realised that the pumps were stored and used in air-conditioned rooms but my workshop was much hotter. So, maybe I was seeing a thermally-sensitive fault. Yet, that couldn't really explain why the errors had only started after a prolonged period of non-use or why a battery replacement had initially cured all the faults.

Freezer spray confirmed that the fault was indeed thermally sensitive but it was difficult to spray individual components on the tightly packed boards. As a result, I moved some suspect components off-board by mounting them on stiff wire links so that I could spray them individually. Those components passed any test I could throw at them and weren't at all sensitive to the freezer spray.

In fact, the fault seemed to be more related to frost on the PCB from the freezer spray than to the actual temperature.

Then I had another thought: humidity. It was a very long bow to draw but it might just be plausible. For most of the last year, the pumps had been stored and used in a room with modern air-conditioning. Then, not long before the holidays, we had to move them to a room with ancient and poorly controlled air-conditioning – this at a time when Queensland was in the midst of an extremely wet summer.

The boards had a fair amount of sticky brown flux on them (dating back to their manufacture), especially on the wire connections to the ultrasound transducers for the "air-in-line" system. And like many devices that have been used in hospitals, the insides of the pumps had a thick crust of dried saline along the bottom, just below the faulty circuits. This could have absorbed moisture and increased the humidity inside the case.

It was time to put my theory to the test so I scraped away all the residues and cleaned off the flux. I then washed the "air-in-line" boards in water and isopropyl alcohol, dried them for a week in silica gel and coated them in a protective lacquer.

Once reassembled, the errors had gone. So it seems my earlier battery and transistor replacements only cleared the faults temporarily by virtue of the circuits drying out while the case was open. Hopefully, I have now found the real cause but I'm still waiting for them to bounce my way again. SC

The photo below shows how the small IR-To-UHF Converter board fits inside a universal remote control while at right is the companion UHF-To-IR Converter.

By JOHN CLARKE

Add a UHF link to a universal remote control

Remote control extenders are old hat. Now you can add this tiny UHF module to your IR remote control and operate appliances from anywhere inside or outside your home. As well as the tiny module inside the remote, you also need our UHF-To-Infrared Converter which is positioned close to the device to be controlled.

OVER THE YEARS, we have produced several infrared remote control extenders, the most recent being in October 2006. That project essentially received the IR signal from any remote control and the signal was then retransmitted using an IR LED that was attached to a long lead. This could be placed closer to the appliance being controlled (eg, in another room).

More recently, there have been UHF remote control extenders. These receive the pulsed IR signal from the remote control and then re-radiate it at 2.4GHz. You then have a UHF receiver elsewhere in your home which picks up the 2.4GHz signal and converts it back to infrared pulses to be received by the appliance being controlled.

Both approaches make sense but why not have a remote control that works at both infrared and UHF, rather than having a separate transmitter unit? So that is what this project is about. You build a tiny UHF module into the remote control and power it from the remote's AA cells; there's no external remote transmitter and power supply to worry about.

Of course, you still need a UHF receiver/IR converter at the appliance end and that's also described here.

This approach is so much more convenient than past remote control extenders. For example, say you are out on the balcony having a pleasant lunch and the CD player is inside providing background music. Want to change a track and change the volume? No need to wander back inside, find the remote and then wander out again. You just pick up the same hand-held remote that you use inside and use it where you are.

Both the UHF and infrared signals are radiated simultaneously, so it does not matter whether you are inside your home or outdoors.

Sound like a good idea? We thought so too and this project is the result.

We have designed a small PCB module that fits inside the remote control case. You will need to check that it will fit inside the remote control that you want to convert. Some remote controls will be too small or have very little room inside the case but many do have enough room, particularly universal remotes.

What about current drain?

But what about the extra current that will be drawn by the UHF module?

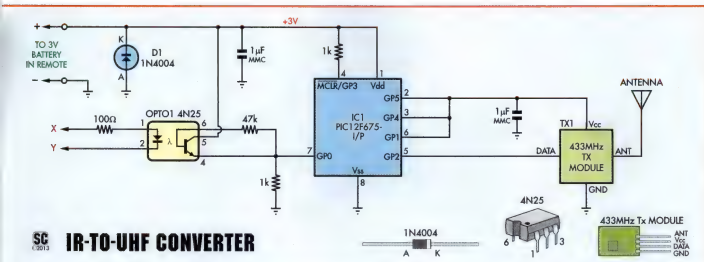


Fig.1: the IR-To-UHF Converter circuit. The IR LED driver circuit in the remote feeds the 38kHz signal in via OPTO1 and this drives pin 7 of PIC microcontroller IC1. The micro then powers and drives the 433MHz transmitter module (TX1).

Will it drain the cells by too much and greatly reduce their life? No-one likes having to continually replace batteries in remote controls.

For this reason, we have been very careful with this aspect and the current drain is truly negligible. Typically, it will be just a few nanoamps although we measured one of our prototypes at just 200 picoamps! That's much less than one thousandth of a microamp!

Compare that with the typical microamp or so drawn by a remote control from its AA or AAA cells. Naturally, more current is drawn from the battery when transmitting both the IR and UHF pulsed signal but it still does not amount to much. In a typical universal remote, the average current while transmitting increases from 10mA with IR transmission alone to 12mA with both IR and UHF transmission – an increase of just 2mA.

Since remote controls only draw significant current while buttons are being pressed, the overall extra current drain with UHF transmission added is unimportant. The AA or AAA cells will still last their shelf life (years).

The companion UHF-To-IR Converter is housed in a small plastic case. At one end of the case it has a red acknowledge LED as well as an IR LED to retransmit the received UHF signal as an IR signal. As well, there is a 3.5mm socket to allow connection of an external IR LED (ie, via a cable).

The converter runs from a 9-12V DC plugpack and it draws a maximum of 50mA when transmitting, so any 9-12V DC plugpack will be suitable.

Circuit details

Fig.1 shows the circuit of the IR-To-UHF Converter to be built into the remote control. It uses an optocoupler (OPTO1), a PIC12F675 microcontroller (IC1) and a tiny UHF transmitter module (TX1) which runs at 433MHz. As stated, it's powered from the remote's two AA (or AAA) cells (ie, 3V).

The optocoupler is needed to allow for any of the possible LED drive arrangements and provides isolation from the rest of the circuit. The various possibilities are shown in Fig.2. The input of the optocoupler connects, via a 100Ω resistor, across the IR LED drive circuit on the remote control's PCB.

For example, in the Altronics A-1012 universal remote, the IR LED drive is as depicted in Fig.2(a). In this case, the "X" terminal input to the optocoupler connects to the +3V supply rail and the "Y" terminal connects to the cathode of the IR LED.

For arrangements such as Fig.2(b), the +3V positive rail is easily accessible but the LED driver output needs to be picked off the series resistor itself. You may need to lift out the remote's PCB to access this resistor.

The optocoupler's internal transistor is connected as an emitter follower, with its base tied to the emitter with a 47kΩ resistor to speed up switching. The resistor effectively discharges the transistor's base each time the opto's internal IR diode stops emitting (ie, at the end of each pulse in the 38kHz signal burst). This allows the transis-

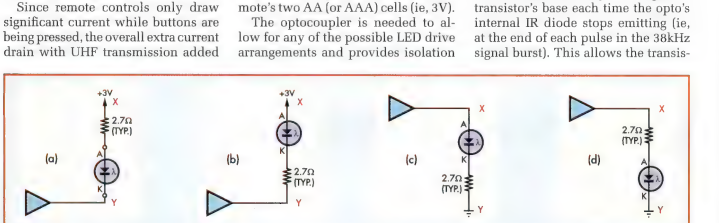
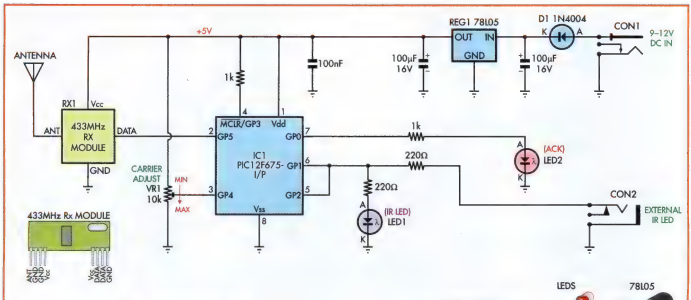


Fig.2: the four possible IR LED driver arrangements in a remote control. The signal drive to the IR-To-UHF Converter must be taken from the points labelled "X" and "Y" (see text for determining the configuration of your remote).



UHF-TO-IR CONVERTER

Fig.3: the UHF-To-IR Converter circuit picks up the transmitted 433MHz signal using RX1 and feeds it to PIC microcontroller IC1. IC1 in turn drives an infrared LED (LED1) and an acknowledge LED (LED2).

tor to switch off faster than if its base were left floating.

The opto's emitter signal is applied to the GP0 input (pin 7) of microcontroller IC1. With no 38kHz signal burst present at pin 7, IC2 is in sleep mode. Its GP1, GP2, GP4 & GP5 outputs are all low, so transmitter TX1 is off and the circuit draws minimal power at around 12nA.

At the onset of signal at pin 7, IC1 wakes up and sets its GP1, GP4 & GP5 outputs high (3V) to power up the UHF transmitter (TX1). IC1 also demodulates the 38kHz signal, so that the output at pin 5 is identical to the original modulation on the 38kHz bursts.

TX1 transmits the UHF signal using a 170mm antenna which is just a length of hook-up wire. After a period of 600ms with no 38kHz signal, power to TX1 is removed with GP1, GP4 & GP5 going low.

Using a microcontroller might seem like overkill for the circuit. However, it was chosen simply because it can be put to sleep and thereby draw negligible current from the remote control's cells. Any other approach, such as using a couple of CMOS timers (eg, 7555), would have much higher current drain than the remote control itself.

UHF-To-IR Converter

The modulated UHF signal needs to be detected and converted back to a stream of infrared pulses to control the appliance being operated. For that we need the separate UHF-To-IR Converter referred to above.

The converter circuit is shown in Fig.3 and comprises UHF receiver RX1, another PIC12F675 microcontroller (IC1) and an IR LED (LED1). The whole circuit is powered from 9-12V DC.

The UHF receiver is powered continuously, so that it is ready to receive a transmission from the IR-To-UHF Converter in the hand-held remote. With no signal present, the data output from the UHF receiver is just random noise with an amplitude of 5V. In this state, the receiver operates at maximum gain, due to its automatic gain control (AGC).

When a UHF signal is received, the AGC reduces the receiver's sensitivity so that the detected signal is essentially noise-free. This is fed to the GP5 input (pin 2) of PIC micro IC1.

To determine if a signal is valid, IC1 checks for periods where the data line from the UHF receiver is at 0V for at least 8ms. This indicates that the AGC has reduced the sensitivity of the receiver and that a transmission is occurring. The 8ms periods also indicate breaks between successive bursts of 433MHz signal.

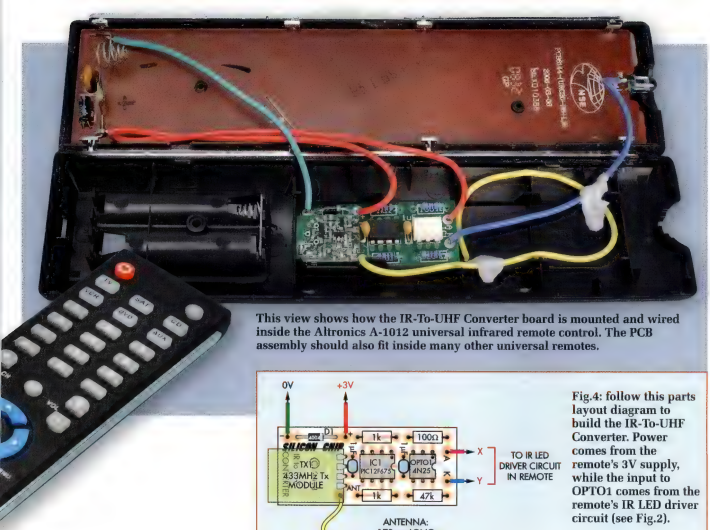
IC1 drives the IR LED (LED1) and

Measuring The Standby Current

How do we measure a standby current of only 12nA? After all, this is far below the current ranges of any digital multimeter.

The procedure is to feed the supply to the circuit via a 100kΩ resistor but with a switch connected across it to allow the circuit to be powered up normally; it does draw more current at power up. Then, after a second or so when the micro has gone to sleep, the switch is opened and the voltage across the resistor is measured.

For 12nA, the voltage measured across the 100kΩ resistor is 1.2mV.



This view shows how the IR-To-UHF Converter board is mounted and wired inside the Altronics A-1012 universal infrared remote control. The PCB assembly should also fit inside many other universal remotes.

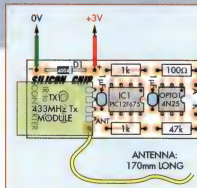


Fig.4: follow this parts layout diagram to build the IR-To-UHF Converter. Power comes from the remote's 3V supply, while the input to OPTO1 comes from the remote's IR LED driver circuit (see Fig.2).

an Acknowledge LED (LED2) from its GP1, GP2 & GP0 outputs; ie, GP0 drives LED2, while GP1 & GP2 drive LED1. Note that the acknowledge LED does not simply follow the data signal level; it is only intended as a visible confirmation that a valid signal is being received.

A second output is provided via a 3.5mm jack socket (CON2) for an external IR LED (if necessary). This LED can be wired to a 3.5mm jack plug on the end of a cable to allow the LED to be attached or mounted near to the IR receiver of the appliance(s) being operated.

The GP4 input of IC1 monitors the voltage set by trimpot VR1 which is across the 5V supply rail. Its wiper voltage is converted to a digital value within IC1, allowing the IR carrier frequency to be adjusted to suit the particular infrared receiver in the appliance under IR control. The adjustment range is from 33.33kHz to 47.66kHz in 10 steps.

Setting VR1 to its mid position gives 38kHz. Usually, 38kHz is satisfactory but some remotes may require a different carrier frequency to this.

Power is derived from a 9-12V DC plugpack. This is fed in via diode D1 which provides reverse polarity protection. A 78L05 3-terminal regulator then provides a 5V supply for RX1 and IC1.

Main Features & Specifications

IR-To-UHF Converter

Transmission range to UHF receiver: >30m

Signal detect delay: 62µs for start and finish

UHF transmitter power down: 600ms from end of signal

Standby current: 12nA typical (12nA measured on prototype)

Operating current: unmodified IR hand-held remote = 10mA; with UHF transmission = 12mA total

UHF-To-IR Converter

Valid transmission: requires 8ms minimum quieting period

Acknowledge LED: 654ms time-out after a valid signal

Modulation frequency adjustment: 33.33-47.66kHz in 10 steps

Current consumption: 50mA during reception and transmission of an IR signal

IR transmission range: typically 2m to appliance receiver

IR-To-UHF converter assembly

Refer now to Fig.4 for the assembly

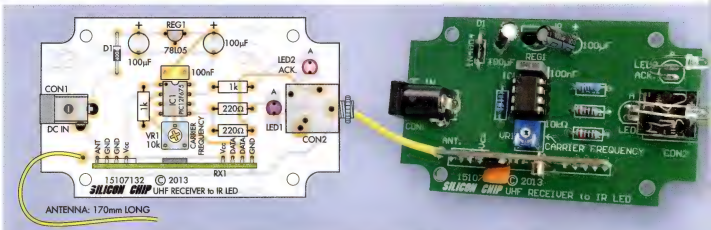


Fig.5: this parts layout diagram and the accompanying photo show the assembly details for the UHF-To-IR Converter. Trimpot VR1 sets the output IR carrier frequency and should initially set mid-way to give a frequency close to 38kHz.

details on the IR-To-UHF Converter. It's built on a PCB coded 15107131 and measuring just 20 x 47mm.

Begin by checking the PCB for any faults (rare), then start the assembly by installing the resistors and diode D1. Table 1 shows the resistor colour codes but you should also check each one using a digital multimeter. Make sure the diode is installed with the correct polarity.

The two capacitors go in next, followed by IC1 and optocoupler OPTO1. Both IC1 & OPTO1 are soldered directly on the PCB since there is insufficient space in the remote control case to allow sockets to be used.

Follow with the 433MHz UHF transmitter (TX1). This is installed parallel to the PCB, so its leads have to be bent down by 90° before soldering it in place. It should be stood off the PCB slightly so that it is about same height above the PCB as the ICs. Once it's in, install the 170mm-long antenna wire.

Installation

The first step in the installation is to open the remote control case. For the Altronics A-1012, a screw within the battery compartment must first be removed, after which the two halves of the case can be carefully prised apart using a wide blade.

It's then just a matter of installing the power supply leads and the leads that run from the remote's IR driver circuitry to the optocoupler. Note that the supply leads must be run around the edge of the case, so that they don't foul other parts when the case is closed. If necessary, notches can be cut into any internal plastic ribs and the wires pressed into these notches.

Make sure that the supply leads connect across the full 3V supply (and not just across one cell) and be sure to connect them the right way around.

As shown in Fig.2, the IR LED can be driven in several different ways, depending on the remote control. This will determine how the "X" & "Y" connections from the converter are wired to the remote's IR driver circuitry.

Fig.2(a) and the photos show the connection for the Altronics A-1012 remote. You can determine how the IR LED is connected in your particular remote using a multimeter (DMM).

First, set the DMM to a low ohms

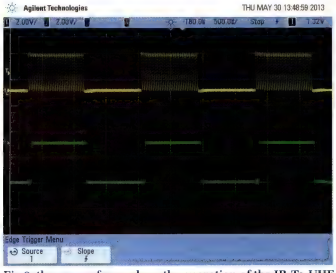


Fig.6: these waveforms show the operation of the IR-To-UHF Converter installed in the remote control. The yellow trace shows the bursts of 38kHz applied to the IR LED. These are coupled via the optocoupler to the microcontroller which then sends pulses of the same length to turn on the 433MHz transmitter (green trace). Scope timebase speed is 500µs/div.

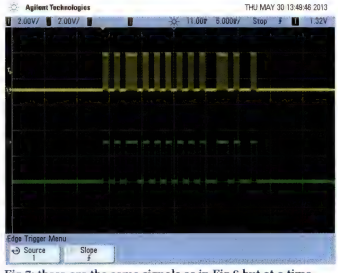
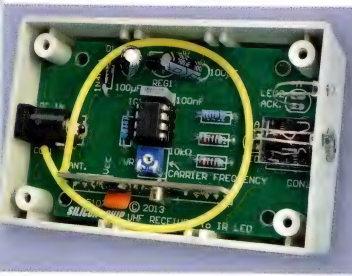


Fig.7: these are the same signals as in Fig.6 but at a time-base speed 10 times slower, at 5ms/div, to show the entire data block being transmitted. Note that there is a delay of about 50µs between the 38kHz bursts and the equivalent pulse fed to the transmitter. This is processing delay in the microcontroller.



The completed board assembly clips into the integral side ribs in the UB5 plastic case. Note how the IR LED (LED1) is bent across the top of the 3.5mm jack socket.

range, then short its leads together and check that it shows a 0Ω reading. Clean the multimeter contacts if the reading is above 0.5Ω. Now, with the two cells removed from the remote, measure the resistance between the anode of its IR LED and the positive battery terminal.

The readings are interpreted as follows:

(1) a reading of about 2-3Ω means that circuit is as shown in Fig.2(a) – ie, the limiting resistor is in series between the supply and the IR LED;

(2) a 0Ω reading between the anode and the positive terminal means a direct connection like that shown in Fig.2(b).

If you get a high resistance reading, check the resistance between the cathode of the IR LED and the negative battery terminal. In this case, the readings indicate the following:

(3) a reading of about 2-3Ω means that circuit is as shown in Fig.2(c)

(4) a 0Ω reading indicates the arrangement shown in Fig.2(d).

Once you've determined the configuration, it's simply a matter of tracing the connection from the IR LED to its limiting resistor and then running the leads back to the "X" & "Y" connections on the converter PCB. In practice, this means that you have to take the drive from across the IR LED and its series limiting resistor. Be sure to get the connections to the remote's drive circuit the right way around, otherwise the converter won't work.

UHF-To-IR Converter assembly

The companion UHF-To-IR Converter is built on a PCB coded 15107132 and measuring 79 x 47mm. This clips neatly into a UB5 plastic utility box measuring 83 x 54 x 31mm and a front-panel label (78 x 49mm) is affixed to the lid.

Fig.5 shows the parts layout on the PCB. Install the resistors and diode D1 first, taking care to ensure that the latter is correctly orientated. The capacitors can then be fitted; make sure that the two 100µF electrolytics go in with the correct polarity.

REG1 can then be mounted, followed by the DC socket (CON1), the 3.5mm jack socket (CON2) and trimpot VR1 (set it mid-way). That done, install the UHF receiver (RX1), making sure it goes in the right way around.

Installing the LEDs

Now for the two LEDs. LED1 must be mounted at full lead length (25mm) so that it can be later bent over and its lens pushed through a hole in the side of the box (above the 3.5mm socket). LED2 is mounted with the top of its lens 20mm above the PCB surface. That's done by pushing it down onto a 15mm cardboard spacer inserted between its leads before soldering it to the PCB. Make sure the LED is orientated correctly, with its anode (longer) lead going to the pad marked "A".

Finally, complete the PCB assembly by fitting a 170mm-long antenna wire.

The PCB assembly can now be completed by installing an 8-pin DIL socket for IC1 but do not plug the PIC micro

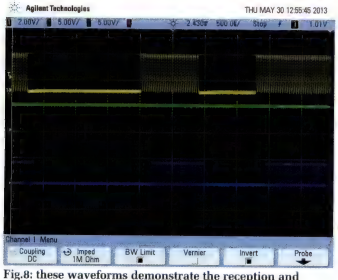


Fig.8: these waveforms demonstrate the reception and conversion of the remote control's 38kHz infrared pulses. The yellow trace shows the remote's 38kHz signal, the green trace is the Acknowledge LED signal and the blue trace shows the infrared pulses emitted from the UHF-To-Infrared Converter. The scope timebase speed it 500µs/div.

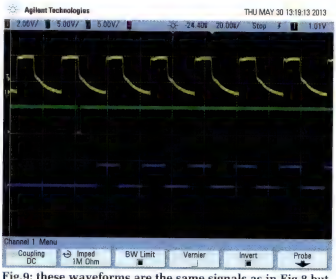


Fig.9: these waveforms are the same signals as in Fig.8 but with a timebase speed 10 times faster to show more detail. Note the rounding of the trailing edges of the transmitted 38kHz IR pulses (yellow trace) from the remote control but the much cleaner signal being re-transmitted from the UHF-To-Infrared Converter (blue trace).

Modifying The 10-Channel Remote Control Receiver

Simple changes let you install the IR receiver & the 433MHz UHF receiver at the same time for use with both IR & UHF remotes

As good as it is, last month's 10-Channel Remote Control Receiver can be even more useful when teamed with an IR remote control that's fitted with the tiny IR-To-UHF Converter. A couple of modifications to the PCB and some revised software for the microcontroller now allows it to be used with both IR & UHF remote control signals.

By JOHN CLARKE

With the tiny UHF module installed in a remote, you can control the modified 10-Channel Remote Control Receiver via both IR and UHF signals. When the remote control is within line of sight, the the receiver works by relying on IR signals. However, if you are in another room or outside your home, then the link is via UHF and the operation is seamless; there's no need to do anything to change modes.

Alternatively, you could have two remotes to control the 10-Channel Remote Control Receiver, one unmodified and one with the UHF module installed. For example, the receiver unit could be in your workshop or garage (to operate the doors perhaps) and you could have the option of controlling it using an unmodified IR unit located nearby or via a modified unit with UHF from inside the house.

The circuit changes required to make this possible are quite simple. The original circuit has both the IR signal from IRD1 and the UHF signal from RX1 being applied to the RB3 input of IC1. In practice, this meant that you had to choose between installing either the infrared receiver (IRD1) or the UHF receiver (RX1) and install or remove the SET link accordingly.

By contrast, the revised circuit allows both IRD1 and RX1 to be installed and the micro automatically selects between them. Fig.10 shows the circuit details. As can be seen, IRD1's signal is applied to the RB3 input, while RX1's signal is now applied to the RB2 (SET) input. The microcontroller separately checks for signals from either path and chooses the first valid signal.

Modifying the PCB

To modify the original PCB (coded 15106131), first cut the track that leads from the DATA output of the UHF receiver (RX1) at the point where it connects to the track that runs from IRD1's pin 1 output to pin 9 of IC1. Note that this track is on the top side of the PCB. Do not break the connection from pin 1 of IRD1 to pin 9 of IC1.

That done, solder an insulated wire link under the PCB between the DATA output of RX1 and pin 8 of IC1. The SET jumper must be left out.

Both IRD1 and RX1 need to be installed on the PCB for both reception modes to be available. If you only install one of these, the unused input

in at this stage. That step comes later, after the power supply has been tested.

Final assembly

The PCB simply clips into the integral ribs of the UB5 case. Before doing this, you need to drill holes in the case ends for the DC socket, the 3.5mm socket and the two LEDs.

The DC socket hole can be drilled first. This is positioned 6.5mm down from the top lip of the base at the left-hand end and is centred horizontally. Start this hole using a small pilot drill to begin with, then carefully enlarge it to 6.5mm using a tapered reamer.

At the other end of the case, the 3.5mm socket hole is also centred horizontally and is positioned 10.5mm down from the lip. Again, use a pilot drill to start it, then enlarge it to 6.5mm. The hole for LED1 is then drilled 3.5mm down from the lip directly above the socket hole. Drill this hole to 3mm, then drill a similar hole for LED2 about 12mm to the right.

The PCB can now be clipped into the slots in the side ribs of the box (push the 3.5mm jack socket into its hole first). Once it's in place, the two LEDs are then bent over and pushed through their respective holes in the adjacent end. Secure the assembly by fitting the nut to the jack socket.

Finally, the front-panel label can be downloaded (in PDF format) from www.siliconchip.com.au (go to "Shop" and then "Panel artwork"), printed out on photo paper and affixed to the lid using silicone or some other suitable adhesive. The four corner holes for the case screws are cut out using a sharp hobby knife.

Note: the panel artwork is free to subscribers or if you purchase the PCB

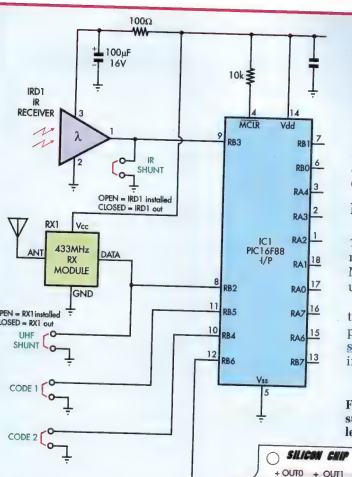


Fig.10 (above): the revised front-end circuit for the 10-Channel Remote Control Receiver. The outputs from IRD1 & RX1 are now fed to separate inputs in IC1 and the micro automatically selects between them.

at pin 8 or pin 9 must be tied to ground. So, if IRD1 is out of circuit, bridge pins 1 & 2 of IRD1's pads. If RX1 is out of circuit, install the SET jumper.

Modified PCB

A modified PCB, code 15106133, is also available that includes the necessary track modifications.

Fig.11 shows the parts layout for this PCB. If both IRD1 and RX1 are installed, then both the IR SHUNT and UHF SHUNT jumpers are left out. If either IRD1 or RX1 is left out, then its associated shunt jumper must be installed.

Revised software

The revised software for the microcontroller is coded 1510613B. It must be used regardless as to whether you modify the original PCB or use the revised PCB design. Note: this software is not suitable for use with the original unmodified PCB.

The new software is available for download from the SILICON CHIP website, while the revised PCB can be purchased from the SILICON CHIP Online shop at **www.siliconchip.com.au** The software is free to subscribers or if you purchase the PCB, otherwise a small fee applies.

Fig.11 (below): the parts layout for the modified PCB. Be sure to install the relevant SHUNT jumper if its receiver is left out of circuit (see text).

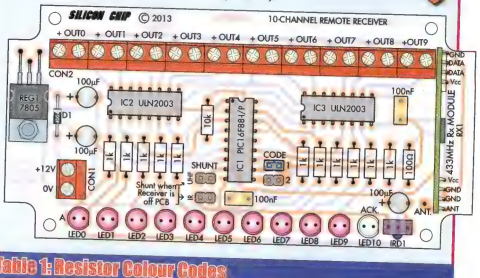


Table 1: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	47kΩ	yellow violet orange brown	yellow violet black red brown
4	1kΩ	brown black red brown	brown black black brown brown
2	220Ω	red red brown brown	red red black black brown
1	100Ω	brown black brown brown	brown black black black brown

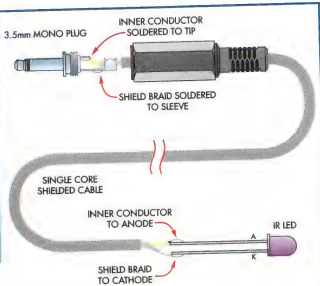
from the SILICON CHIP Online shop, otherwise a small fee applies.

Testing

To test the unit, first check that IC1 has not been installed. That done, apply power and check that there is a 5V supply between pins 1 & 8 of the IC socket. If you don't get 5V, check the supply polarity and that D1 and REG1 are installed the right way around.

Assuming you do get 5V, switch off and install IC1 with its notched end towards the adjacent 100nF capacitor. Now reapply power and check that the red acknowledge LED flashes when the remote control buttons are pressed.

The next step is to set the universal remote control so that it produces the correct code for your appliance. That done, test it without the UHF-To-IR



Making An IR LED Extension Cable

Depending on how your gear is arranged, you may also want to make up a cable with a 3.5mm jack plug at one end and an external IR LED at the other. Fig.12 shows the details. You will need to use a suitable length of single-core shielded cable, while the LED leads should be insulated from each other using heatshrink tubing.

A larger piece of heatshrink can then be used to cover the end of the cable, both LED leads and part of the lens.

Fig.12: here's how to make an IR LED extension cable if you need one.

Parts List

IR-To-UHF Converter

1 infrared remote control (eg, Altronics A-1012)
1 double-sided PCB, code 15107131, 20mm x 47mm
1 433MHz transmitter (Jaycar ZW-3100, Altronics Z 6900) (TX1)
1 170mm length of yellow light duty hook-up wire
1 200mm-length red hook-up wire
1 200mm-length green hook-up wire
1 200mm-length blue hook-up wire

Semiconductors

1 PIC12F675-I/P programmed with 1510713A.hex (IC1)
1 4N25 or 4N28 optocoupler (OPTO1)
1 1N4004 1A diode (D1)

Capacitors

2 1µF monolithic ceramic (MMC)

Resistors (0.25W, 1%)

1 47kΩ 1 100Ω
2 1kΩ

UHF-To-IR Converter

1 double-sided PCB, code 15107132, 79 x 47mm
1 UB5 box, 83 x 54 x 31mm
1 front panel label, 78 x 49mm
1 433MHz receiver (Jaycar ZW-3102, Altronics Z6905A) (TX1)
1 PCB-mount 2.5mm DC socket
1 3.5mm PCB-mount switched jack socket
1 DIL8 IC socket
1 170mm-length of light-duty hookup wire
1 10kΩ miniature horizontal trimpot (VR1)

Semiconductors

1 PIC12F675-I/P programmed with 1510713B.hex (IC1)
1 78L05 regulator (REG1)
1 1N4004 1A diode (D1)
1 3mm IR LED (LED1)
1 3mm red LED (LED2)

Capacitors

2 100µF 16V PC electrolytic
1 100nF MKT polyester

Resistors (0.25W, 1%)

2 1kΩ 2 220Ω

Optional

1 3.5mm mono jack plug
1 1m length single core screened cable
1 3mm IR LED
1 100mm length 3mm-diameter heatshrink tubing

Converter (ie, turn the converter off) first to ensure the appliance can be controlled using IR signals only.

Once that works correctly, the unit can be tested with the UHF-To-IR Converter unit. Note that the converter's IR LED should be pointed in the general direction of the appliance to be controlled.

To test it, power up the UHF-To-IR Converter, cover the IR LED on the remote with a finger and check that the appliance can be controlled via the UHF radio link. If it doesn't work, adjust VR1 as you operate the remote control until the appliance responds. Usually, setting VR1 mid-way (corresponding to a carrier frequency of 38kHz) will be suitable.

Once it's operating correctly, try using the remote to control the appliance from another room. You should get a free-air range of 30 metres of more but the range will be less than this inside a house, depending on any obstacles (walls, etc) between the remote and the UHF-To-IR Converter.

Finally, note that the IR receivers in many appliances are so sensitive that they will respond to IR signals that are bounced off the walls or the ceiling of the room. So experiment before going to the trouble of making up the extension cable if you can't aim the IR LED in the UHF-To-IR Converter directly towards the appliance. SC

Two demonstration circuits for human colour vision

By JAMES GODING

THE HUMAN EYE can see a range of different colours, representing light with a range of wavelengths from about 680nm (deep red) down to about 390nm (deep violet). But we can be fooled into seeing many colours by a TV screen that contains just red, green and blue light emitters (RGB).

Why is that? And why do printers and artists use a different set of colours: cyan, magenta, yellow and black (CMYK)?

These two simple circuits aim to reveal the operation of the human eye and clear up the mysteries through practical demonstrations. Build them into little boxes and you will have a source of delight and amusement for children, and education for young and not so young adults.

The human eye contains two types of photo-receptor: around 120 million "rods", which are concentrated around the edges and 6-7 million "cones" which are mostly in the centre of the retina (the fovea). The cones allow us to see colour and most people have three types, with broad sensitivity peaks centred towards the red end of the spectrum (560 nanometres), green (530 nanometres) and blue (420 nanometres) – see Fig.1.

The perception of colour by the brain depends on the relative amounts of stimulation of each of these types of photo-receptor. Because the photo-receptors have persistence, rapidly alternating red and green light gives the effect of stimulating the red and green receptors simultaneously. The brain interprets this as yellow. And because the photo-receptor absorption peaks are broad, pure yellow light at 585-590nm also stimulates both red and green receptors.

This is demonstrated by the circuit of Fig.2. IC1 is a 555 timer which generates a quasi-sawtooth waveform with a frequency set using potentiometer VR1. This is buffered by op amp IC2b, half of an LMC6482 rail-to-rail op amp and then fed to the other half of this op amp which acts as a comparator. VR2 is used to adjust the voltage which the sawtooth waveform is compared against, producing a variable-duty cycle PWM output at pin 1 of IC2a.

This output is used to drive the red element in LED1 which emits light at 625nm. The same signal is also fed to PNP transistor Q1, which acts as an inverter, turning on the green element (568nm) while ever the red one is off and vice versa. So you can use VR2 to adjust the relative on-times of LED1 and LED2 while changing the frequency with VR1.

When the rate of flashing is slow and the duty cycle is set at about 50%, the viewer sees alternating red and green but as the flashing rate is increased, there comes a point where the LED appears yellow. Under conditions of rapid flashing, when the duty cycle knob is rotated, there is a smooth transition from red to orange to yellow and then to green. Slowing the flashing rate provides proof that no trickery is involved.

Note that the red and green cone sensitivity curves shown in Fig.1 overlap much more closely than do the green and blue. Despite this, we are still able to distinguish subtle variations in the shades between green and red because our brains are interpreting the differences in absorption between the two different types of cone cell.

We should point out that some 8% of Caucasian males have red/green colour blindness (dichromacy), mostly due to genetics. Because females have two X chromosomes and the genes to express colour vision are on this chromosome, they effectively have two copies of these genes and so are much less likely to develop colour blindness. While called "blindness", in most cases the result is a reduction in the ability to distinguish between certain shades of red, yellow and green.

People with one of these conditions will perceive the transitions between red, green and yellow (if visible) at different points than those without.

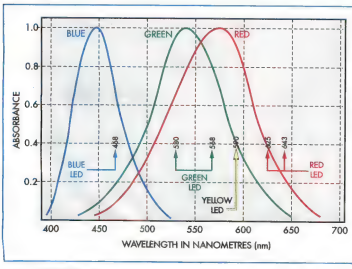


Fig.1: the human eye has three colour sensitivity peaks centred on 560nm (red), 530nm (green) & 420nm (blue).

YOUR CHOICE

That's what it's all about. . .

Now that the new SILICON CHIP website is up and running, your choices have never been wider when it comes to the way you subscribe. Subscriptions are available for 6, 12 and 24 months.

WANT TO SUBSCRIBE TO THE PRINT EDITION ONLY (as you've always done)? No worries!
WANT TO SUBSCRIBE TO THE ON-LINE EDITION ONLY (it's all new!)? No worries!
WANT TO SUBSCRIBE TO BOTH THE PRINT EDITION AND THE ON-LINE EDITION? No worries!

And that's what makes your choices even more valuable.
Say you're away from home when your printed copy is normally delivered...
Say you want to look up something# in SILICON CHIP from a previous issue when you're at work ...
Say you want to search# for a particular project or feature from any issue...
No worries — even if you're on the other side of the world, you can read – in full – the current issue of SILICON CHIP with a desktop, laptop, notebook or tablet PC* – anywhere you can access the 'net.
And this convenience comes at a very small premium over the printed subscription price.

PLUS! While ever your subscription is current, you can download software, PCB patterns, front panel artwork, etc, FREE OF CHARGE!

Here's the deal:

Full access to articles requires subscription. Search *facilities* do not.
* Must be capable of running Adobe Flash

IF YOU'RE IN AUSTRALIA you can subscribe to the print edition (only) of **SILICON CHIP** for $105.00 for a full year – 12 issues (that's almost $15 less than the over-the-counter price – and we pay the postage!)
FROM ANYWHERE IN THE WORLD, you can subscribe to the on-line edition (only) of SILICON CHIP for $AU85.00 for 12 issues. (Of course, you can also subscribe to the printed edition outside Australia).
Or in Australia you can subscribe to BOTH the print edition AND the on-line edition, for the ultimate in versatility, for just $125.00 (yes, that's only $20 over the print edition subscription price). That's a very handy option for anyone who is travelling – read **SILICON CHIP** online from anywhere in the world!
You can also convert from a printed edition or on-line edition to a combined edition if you wish.
There are many other options available, such as shorter or longer subscription (eg, 6 and 24 months), New Zealand/other overseas offers, subs with binders (Australia only) and so on.
There are far too many to list here but they are all fully explained on the "subscript*ions*" page on the website: **www.siliconchip.com.au**

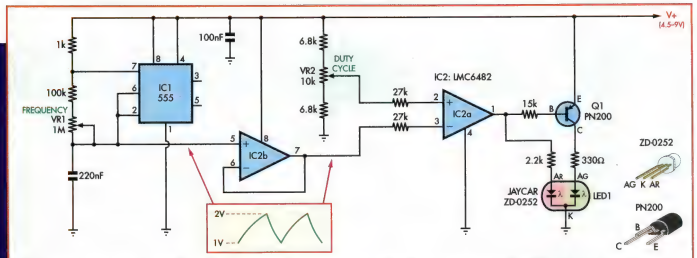


Fig.2: this demonstration circuit uses a 555 timer as a sawtooth oscillator. Its output is buffered by IC2b & compared in comparator IC2a with a voltage set by VR2. IC2a then directly drives the red section in a bi-colour LED (LED1) & the green section in LED1 via transistor Q1. VR2 adjusts the relative on-times of the two colours.

By the way, it is a myth that dogs and cats can't see colour – they have two types of cones, blue and yellow, giving them similar (but not identical) vision to that of a human with dichromatic colour blindness.

Introducing blue

That brings us to the circuit shown in Fig.3 which uses an RGB LED (LED1), allowing you to experiment with any combination of red, green and blue light to see what colour the result appears. The Jaycar ZD0010 RGB LED used is a "Tri 5 Superflux" with wavelengths of 468nm (blue), 528nm (green) and 643nm (red). The three LED elements are driven by three potentiometer-controlled constant current sources.

LED2 can be virtually any low cost red LED and should be positioned so that its lens is hidden. It is used not for its light but for its forward voltage; this is used to bias the bottom ends of the three pots so as to maximise their useful range of rotation. A 2.4V Zener diode would also work but a red LED is easier to obtain.

If all three knobs are turned fully clockwise, the LED output appears approximately white, since each type of cone in your eye is being stimulated more or less equally. If the blue knob is turned down, the colour changes to yellow. If the red knob is turned down, the colour changes to turquoise (cyan) and if the green knob is turned down the colour changes to purple (magenta).

By manipulating different combinations of the settings of the knobs, any colour can be produced. For example, pink is produced by mixing a small amount of green with a small amount of blue and adding a slight excess of red. This is of course the equivalent of mixing red and white light.

Some limitations should be mentioned. Because the coloured elements of the LEDs are slightly displaced from each other, the colour merging is not quite perfect and the effects are best seen at a slight distance.

Finally, these toys are endlessly fascinating for children but they forget to turn them off. To conserve battery life, a pushbutton switch could be used for the power.

Further experiments

Now let's look at the question we asked in the first paragraph: why do we use CMYK (cyan, magenta, yellow & black) inks rather than RGB (red, green & blue) like a TV or computer screen? The answer is that video displays create colour additively, just like our second circuit. But ink works by absorbing certain wavelengths of light that would otherwise be reflected from the white paper beneath and so we combine inks in a subtractive manner.

Cyan ink absorbs red light, allowing green and blue to be reflected from the white paper and the combination of the reflected green and blue light gives it its cyan hue. Similarly, magenta ink absorbs green light but reflects red and blue, while yellow ink absorbs blue light but not red or green.

So if we put a layer of cyan ink down on paper, then yellow, light that would stimulate the red and blue sensitive cones in our eyes is absorbed, leaving just green wavelengths and thus we see it as green. Similarly, red can be made with magenta and yellow inks and blue can be made with cyan and magenta inks.

Black can be made by combining cyan, magenta and yellow inks but black ink is usually used as well as the other three, since black is a common colour in printing and this reduces the total amount of ink used. There are also other benefits that we won't go into here. **SC**

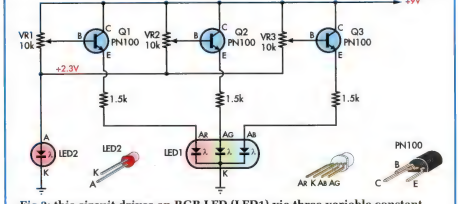


Fig.3: this circuit drives an RGB LED (LED1) via three variable constant current sources based on transistors Q1-Q3 and potentiometers VR1-VR3.

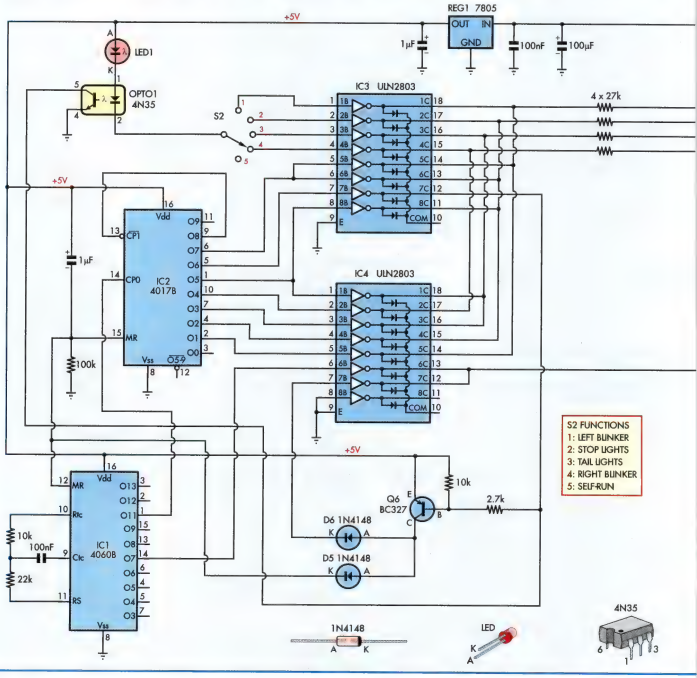
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions will be paid for at standard rates. All submissions should include full name, address & phone number.

Trailer light testing unit

This unit was designed to make testing and checking trailer lights easier and less time-consuming. Rather than connecting each light circuit one by one with alligator clip leads, or asking someone else to operate the lights from within a motor vehicle, the user simply connects the trailer plug into the unit's test socket and the unit then sequentially runs through all the light functions.

Each light function is powered for about nine seconds, eg, the left blinker circuit flashes for a period of nine seconds, then extinguishes, then the brake/stop light function illuminates for nine seconds, then extinguishes, then the tail light function illuminates for nine seconds, then the right blinker flashes for a period of nine seconds, then both the stop and tail lamps function together. The last part of the cycle tests the functions of the left blinker



and the brake/stop lights.

This sequence loads up the common earth wire of the trailer wiring in order to detect high resistance joints and problems in the common earth wire that carries the currents of all the lights. If the earth wire is not adequate, then random and confused lighting can happen.

IC1 is a 4060 wired as an oscillator which simply gives a pulse output close to the flash rate of a typical blinker on most modern vehicles and also a cycle of about nine seconds for each light function. Therefore, the 4017's outputs have an on period of about nine seconds, which energises the appropriate relays for each light function via ULN2803 transistor arrays IC3 & IC4 and BD140 transistors Q1-Q4.

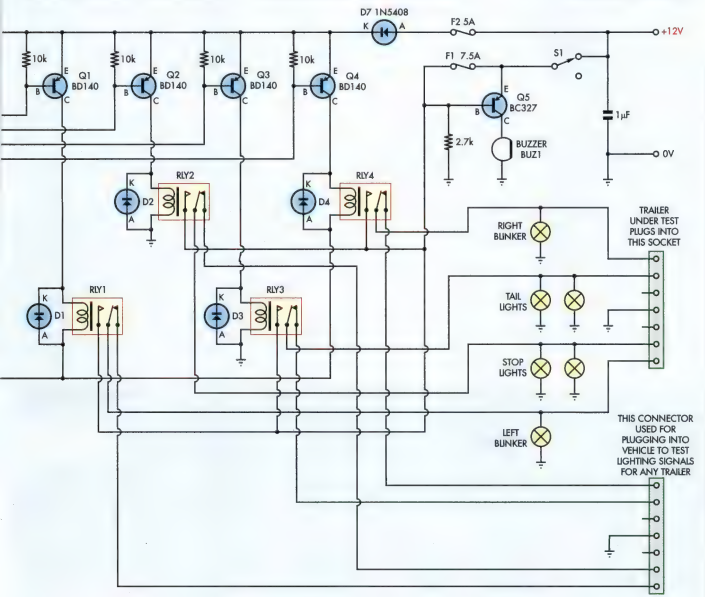
This circuit also allows for applying power to each individual light function on the trailer, for tracing faults such as open circuits, short circuits and poor or intermittent connections between the trailer plug and the lights.

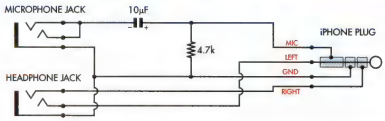
Rotary switch S2 is used to place the circuit into self-run mode (position 5) or to test each individual light function (positions 1-4). When positions 1-4 are selected, the 4N35 optocoupler (OPTO1) is switched on because of current through its input LED via the internal 2.7kΩ resistor of the ULN2803's inputs.

When OPTO1 is on (ie, S2 in positions 1-4), this switches on Q6 and holds both the 4017 and 4060 reset. As a result, for each of these selections, constant power is applied to the lights under test. This includes both the left and right blinkers. In this case, either Q1 or Q4 is switched on constantly to aid fault finding.

When S2 is set to the self-run po-

continued on page 78





Audio breakout cable for the iPhone

It's quite convenient to use an iPhone for audio recording but the internal microphone isn't really up to the job for all but the most basic tasks. You can connect a dynamic or self-powered condensor microphone to the audio in/out jack socket and this greatly improves the situation but the required cable can be quite pricey at around $30.

You can quite easily make one yourself for less; this one cost around $10. You will need a 3.5mm audio/video (4-contact) plug, two 3.5mm stereo line sockets, some shielded cable, a 10µF capacitor and a 4.7kΩ resistor. The 10µF capacitor blocks the DC bias voltage used to power the iPhone's internal electret microphone (~2.7V) while the 4.7kΩ resistor loads down that pin to signal to the iPhone than an external microphone is connected.

If you get a sub-miniature 10µF capacitor (or a tantalum capacitor) then this can be fitted inside the microphone socket housing (assuming you are using a 3.5mm line socket) while if you use a small 0.25W 4.7kΩ resistor, this can be hidden inside the heatshrink tubing used to cover the point where the cables join.

You can use two layers of heatshrink to protect these joints as much as possible and prevent them from coming apart if the cable is subject to abuse during transport or use.

Bruce Pierson,
Dundathu, Qld. ($35)

Trailer light testing unit – continued from page 77

sition 5, OPTO1 is off and the 4060 runs and clocks the 4017. The circuit then sequentially runs through all the light functions on the trailer, rather than the user having to manually select each test.

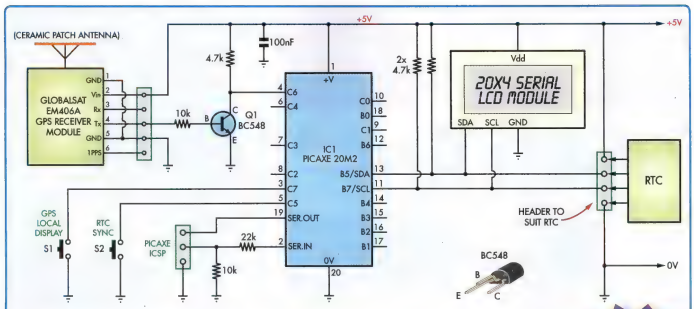
Power comes from the 12V battery which directly feeds the trailer lamps and the relays via fuse F1. Transistor Q5 is connected across the fuse and sounds a warning via the piezo buzzer if the fuse is blown. IC1 and IC2 are fed from +5V from REG1, a 7805 3-terminal regulator.

The changeover relays also provide the means to use the unit to test the light signal outputs of any vehicle with a trailer socket. The unit simply simulates being a whole trailer lamp load and in this mode doesn't need a separate battery to be connected.

This unit can be used for testing both incandescent lamps and also the now common LED lights. On this note though, this unit deliberately uses incandescent lamps to properly load up the light circuits close to worst case current consumption loads, as the smaller LED currents can mask high resistance joints either in the trailer or the towing vehicle.

Note that the unit can be modified to run from 24V without any changes apart from using 24V relays instead of 12V relays. Alternatively, 12V relays could be used together with suitable current-limiting resistors in series with the coils.

Peter Howarth,
Gunnedah, NSW. ($60)



Setting a Real Time Clock with GPS time

Many PICAXE, Arduino and other microcontroller development boards have a Real Time Clock (RTC) for timekeeping and this can be useful in certain applications such as data logging or controlling external hardware on a schedule. You can also get small I²C RTC daughterboards for less than $10. I²C stands for "Inter-IC communications" and is a common 2-wire serial standard.

In most cases, the timekeeping is based on a 32.768kHz crystal and depending on its tolerance and how well it has been calibrated, regular adjustments may be required to correct for drift. The setting of these and other I²C RTCs can be a chore so this circuit was designed to make life a little easier.

When sync button S2 is pressed, the attached I²C RTC is synchronised to GPS time, including setting the date. The circuit is based on IC1, a PICAXE20M2 that receives UTC (Universal Co-ordinated Time) data from an EM406A GPS receiver using an RS-232 serial link. IC1 then transmits the time and date over the I²C bus, to set the attached RTC. An LCD shows both the GPS time/date and that of the connected RTC.

The GPS time/date shown on the LCD can be displayed as UTC time/date, local time/date or local time with daylight saving. These are cycled through using pushbutton S1.

The software is aware of leap years so it can correctly calculate and display the local time and date, based on the UTC time/date from the GPS signal. The time zone is hard-coded into the software so the lines near the top of the file will need to be changed to suit your time zone. Similarly, the I²C address of the RTC is set in the code to a common value for such devices (D0).

For convenience, an I²C display is used so that the micro can communicate with the display and RTC using the same pair of pins, B5 for data (SDA) and B7 for clock (SCL). These have the standard 4.7kΩ pull-up resistors for low-speed I²C.

There isn't much else to the circuit other than a transistor buffer/inverter for the serial signal from the GPS module (Q1), a bypass capacitor for IC1, a PICAXE in-circuit serial programming (ICSP) connector, the two pushbuttons and the LCD. The whole circuit runs from a 5V supply.

David Worboys is this month's winner of a $150 gift voucher from Hare & Forbes

Most of the work in developing the software went into communicating with the LCD and extracting the date from the GPRMC NMEA serial stream. Note that most I²C LCDs use the PCF8574 port expander chip but the pin-outs can vary.

The 20M2 is set to run at 32MHz because there is a lot of number crunching happening in the background between LCD display updates. An LCD update happens whenever an NMEA GPRMC string is detected.

The BASIC source code for this project is available for download from the Silicon Chip website.

David Worboys,
Bankstown, NSW.

ALTRONICS

Build It Yourself Electronics Centre

Issue: July 2013

Top July Deals!

1080p HD Sports Action Camera Pack

X 0684

High definition recording for extreme sports. Waterproof to 20m for underwater use! Amazingly small, just 24 grams in weight and 52mm high. Includes waterproof case, brackets & straps for helmets, bikes etc. Records to Micro-SD (max 32gb).

In-built battery for 2hr record time!

NEW! $135

NEW! $89

A 2752

Listen To Digital Radio On The Go!

Great for listening to the footy commentary at the game. Or accessing the huge variety of new digital stations on offer. Jog wheel tuning with 10 station presets & headphone socket. Requires 4xAA batteries (pick some up in-store!).

NEW! $259

S 9433

Also shoots 12mp still photos!

Dashboard Portable HD Camcorder

Designed both as a dashboard camcorder and a Full HD portable handi-cam for documenting your adventures!

Fully adjustable 2.5" flip screen and rotating lens. Includes car power adaptor & bracket. Great for fleet vehicles & vehicle accident analysis. Can be fitted with 32GB SD card (DA0323 $53.00).

A 2750

SAVE 20% $55

Wake Up To Digital Radio!

An ideal bedside companion! Wake up to your favourite digital or FM station. Large display with scrolling info. 10 presets. Two alarms.

Listen To Tunes Anywhere You Go!

Hooks up to virtually any amplifier, stereo or portable speakers to stream audio wirelessly from your smartphone or tablet. In-built rechargeable lithium battery offers up to 10 hours of music streaming before recharging (via USB).

Just 68mm wide!

NEW! $49.95

A 1102

NEW! $34.95

X 3402

Must have for the flu season!

Take Temperatures Without Fuss!

A quick and painless method for taking kids (and adults) temperature. Measurements take just seconds by placing the end of the unit into the ear. Sealed 'easy clean' temperature sensor.

Compact Bluetooth Keyboard For Tablets

NEW! $74.95

D 2135

A keyboard for your tablet when you need it - can be used without taking your tablet out of its case. Tough aluminium backed keyboard. Folds flat to just 14mm thick! ≈1 month use from a single charge.

NEW! $119

X 0400

Compact design, easy to carry around.

Personal Alcohol Breathalyser

Utilises the same fuel cell technology as law enforcement devices. Far more accurate than most cheap semi-conductor based units. Provides readings for personal use.

Bluetooth® Headset. No tangled cords!

NEW! $69.95

C 9019

Listen to music & take phone calls at the tap of a button! Superb wireless audio performance for music listening, plus inbuilt mic and phone controls for hands-free talking. Range up to 10m. In-built batteries recharge via USB(≈10 hrs operation).

New Products For 2013...

NEW! $229

A 2651

Ideal size for bands, theatre & small venues.

Top Value 6 Channel Mixer With USB Playback

Featuring USB/SD card playback with easy to use controls. All channels feature balanced XLR, unbalanced 6.35mm, insert inputs, high/mid/low adjustment, pan & gain effects level. Channels 5 & 6 are combined on the one fader/controls. Includes power supply.

Connect your turntable to a regular aux input.

This handy little 9V battery powered adaptor gets around a common problem with modern amplifiers - a lack of phono input! Connects to any standard aux level RCA input. Suits magnetic pickups.

Handy problem solver!

A 3051

NEW! $23.95

Away from mains power? No worries!

These mobile battery banks keep your smartphone or tablet charged up even when you are miles from a 240V outlet. 6000mAh 5V 2A out-put. 5-7hr recharge time. Includes a range of adaptors, including Apple (30 pin) & Samsung plugs.

About the size of a phone!

NEW! $59.95

D 0506

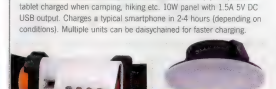
N 0710

NEW! $129

Folds up to about the size of an Altronics catalogue!

Stay Charged Up On Your Travels!

This folding solar panel charger is an ideal way to keep your phone or tablet charged when camping, hiking etc. 10W panel with 1.5A 5V DC USB output. Charges a typical smartphone in 2-4 hours (depending on conditions). Multiple units can be daisychained for faster charging.



X 0202

NEW! $19.95

Waterproof Head Torch

Weatherproof design with 4 high brightness white LED's and adjustable headband. Great for working under cars or camping/hiking. Two brightness settings & flash mode. Requires 2xAAA batteries.

Or 4 for $80!

NEW! $25.95

X 2402

Flush Mount 3W LED Lamp

Runs from 12V or 24V DC - ideal for 4WDs, caravans and RV's. Super low profile (28mm deep) is great for cabinets. 62mmØ mounting hole. Warm white.

Our Build It Yourself Electronics Centres...

» **Springvale VIC:** 891 Princes Hwy » **Auburn NSW:** 15 Short St » **Perth WA:** 174 Roe St
» **Balcatta WA:** 7/58 Erindale Rd » **Cannington WA:** 6/1326 Albany Hwy

Phone Order Now On...

1300 797 007

or shop online 24/7 at www.altronics.com.au

NEW!
$28.95
T 5032

NEW!
$14.95
T 5030

Handy Tool Carry Cases

Impact resistant plastic tool cases with removeable centre section.
T 5030: 315x175x130mm, 5kg.
T 5032: 410x210x185mm, 10kg.

$209
SAVE $50
T 2460
Great for servicing & re-work

Micron® 100W Digital Lead Free Soldering Station

Generates high tip temperatures suitable for lead free soldering (200° to 450°C). In-built power saving mode reduces power consumption and dramatically increases tip life. A high quality ceramic element allows rapid tip heat recovery and consistency. Includes 0.5mm tip.

Optional SMD tweezers T 2461 $119	2 Year Warranty	Suits lead free soldering

20% OFF

Tuff Nut Electrical Gear

Super-Tough Equipment Carry Cases!

IP67 rated for the ultimate dust and water protection for your precious equipment. Ideal for storing test equipment, cameras, computers and sensors. Foam inner can be customised to suit your equipment. Foam lined lid for secure fit. Latches can be padlocked. T 5052-65 include shoulder strap.

*Dimensions are external

Size	Part	Normally	Now..
365x266x165mm	T 5050	$94.95	$74
465x365x185mm	T 5052	$179	$140
515x435x199mm	T 5054	$269	$199
650x430x250mm	T 5065	$485	$379

Just like the brand names for far less!

Get More Tools For Your Dollar...

SAVE $50
$199
Q 1246
Includes SMD measurement adaptor

True RMS DMM & Insulation Tester

Brings together insulation testing functions & a digital multimeter into one compact unit. Internal memory records up to 99 readings.
Features: • 250-1000V insulation testing • Resistance • Frequency • Capacitance • Temperature • Continuity • Backlit LCD • Cat III 1000V, Cat IV 600V

SAVE $20
$139
M 8261
9-15V 20A

SAVE $40
$159
M 8263 9-15V 30A

Powertran® Analog Lab Power Supplies

These compact, fan cooled, switchmode power supplies deliver up to a huge 30A regulated output, adjustable between 9 and 15V. Plus fixed 13.8V setting. Ideal for comms equipment or servicing. Low noise design. 85% efficiency. 155x70x205mm.

Also available in 100MHz

$499
SAVE $100
Q 0200A

Atten® 25MHz Digital Storage Oscilloscope

Perfect for those in R&D, product development or service of complex electronic equipment. Features 2 channels with real-time 500MS/s sampling. The colour 5.7" TFT display screen can be set up to simultaneously display the waveform plus indicate the measured wave voltage, peak to peak plus RMS, frequency, duty cycle etc. Realtime adjustments via PC can be made using included software. Store data to a USB stick or download it to PC. **2 year warranty.**

Ideal for checking response of audio circuits.
Q 1562
SAVE $30
$269

Professional Grade Function Generator

Operates as a standard waveform generator with sinusoidal, triangle and square wave outputs. DC offset and symmetry. Adjustable output between 0.03Hz & 3MHz. Plus a 3 MHz counter. Size: 251W x 291D x 91Hmm.

Ideal for field servicing
T 5036
NEW!
$29.95

Double Sided Parts Case

Nifty parts case with adjustable dividers for up to 15 compartments on one side, plus 10 removeable containers on the other.

±3mm accuracy
T 2251
SAVE $60
$99

Get an accurate distance measurement in seconds!

This laser tape measure provides an instant 'one touch' measurement - up to 30m. Plus calculation modes such as add, subtract, pythagorean, square & cubic measurements.

SAVE 20%
$55
Q 1282
Adjustable for different surfaces.

Contact Free IR Digital Thermometer

...with laser guided beam for pin point accuracy! Professional accuracy for an affordable price. Ideal for measuring whilst equipment is operating. 0.1° accuracy from -20°C to 270°C. Includes batteries.

NEW!
$29.95
T 2171

22pc Palm Ratchet Driver Set

A ratchet wrench designed for working in tight spaces. Fits in the palm of your hand, or use with the optional screw in wrench handle. Supplied with a variety of tips and sockets.

SAVE $30
$119
T 2650

Heavy Duty Go-Anywhere Gas Iron & Blow Torch

Use it anywhere, no need for messy extension leads! The ultimate tool for enthusiasts or tradies. It not only solders (550°C max), it can be used as a blow torch up to 1300°C for brazing and heat shrinking. Self standing design. ≈1.5 hours use per cartridge (mid setting).

9pc 1000V Rated Insulated Tool Kit

Great for electricians, technicians or anyone working on mains equipment! Includes cutters, pliers, wire strippers, 5 screwdrivers, 240V test driver and 2 rolls of tape.

SAVE 20%
$45
T 2175

Great Value AV & PA Equipment

2 Year Warranty

SAVE $71*
$369

Biema® Stereo Power Amplifier - Up to 350W per channel!

A 4156 2x200W

Extraordinary value for money! Brilliant performance, producing a smooth, crisp sound with plenty of grunt when required. **Features** • 6.35mm/RCA inputs • Fan cooled • Binding post, 6.35mm & Speakon outputs • Host of protection features • Power into 4Ω 2 x 350W • Power into 8Ω 2 x 200W.

SAVE $76
$299

A 4154 2x100W

Access over 14,000 internet radio stations from your home hi-fi!

REDUCED!
$399

A 2696

This stylish wireless internet radio player will perfectly compliment your existing AV system. It provides you with access to DAB+ digital radio stations, plus virtually any internet radio station or podcast via wireless internet (no computer required!). Plus it can stream music stored on your PC via UPnP. Size: 430x90x285mm.

A 0977A

SAVE 15%
$24

With Infra-Red Learning

Jumbo 4 in 1 Remote Control

• Great for the kids! • Each button is about the size of a 20c coin! • Pre-programmed with 1000's of codes, plus IR learning • Requires 2xAA batteries • Size: 284 x 128mm.

SAVE 16%
$40

A 1170

Dynalink® Infra-Red Extender Kit

Great for controlling equipment when its located inside cabinets or entertainment units. Kit includes hub, IR target, four IR emitters & power supply. Foxtel compatible (non IQ only).

All metal case

A 2510

SAVE 39%
$18

Direct Injection Box

Converts high impedance (50KΩ) unbalanced signals into low level (600Ω) balanced signal for ultimate sound quality over long lead lengths. No power required.

SAVE 13%
$36

P 8170

Protect Your AV System & Cut Power Consumption!

Power, telephone, aerial and satellite dish surge protection. Allows a master appliance (ie TV) to switch on/off slave appliances automatically, such as receiver, DVD etc. Drastically cuts standby power usage.

NEW!
$54.95

A 3087

Remote Control 3xHDMI Switcher

Mini three input HDMI switcher which can be discretely mounted behind your TV and controlled by remote (external IR receiver included).

About the size of a drink can!

C 5283

SAVE $20
$79/pr

Mini Cube Speakers: Small on size, big on sound!

These mini cubes produce an amazing sound with a subtle appearance. Swivel mount drivers. Ideal for the kitchen, study or bedroom. 15W 8Ω. Size: 130Hx65Wx75Dmm.

Flat Core HDMI Leads

3DTV compatible. Superb quality for any home theatre system. High speed HDMI with Ethernet (V1.4).

Lifetime warranty.

	Part	RRP	Now...
5m	P 7334	$49	$42
10m	P 7336	$89	$79
15m	P 7338	$139	$119

SAVE 26%
$25

A 3084

Value 3 Way HDMI Selector

An economical way to switch between 3 HDMI sources. No power required! Size: 104 x 120 x 26mm.

New 50m rolls. Just 80¢ a metre!

SAVE 26%
50m For
$40

W 2193

High Power Speaker Cable

Great for making speaker leads for live venues or DJ's. Double insulated with soft outer sheath. 1800W rated.

SAVE 22%
$15

C 9555

Hum Loop/Noise Eliminator

Ensures a clean hum free signal on any stereo RCA line. Prevents induced interference on long leads. Simple in-line connection.

Fine Tune Your Sound System

A useful tool for high-end home theatre systems, PA & car audio. This SPL meter measures up to 130dB (1.5dB accuracy). Used widely in the audio industry for ensuring sound levels remain legal. Includes 9V battery.

SAVE $20
$79

Q 1264

Stay Powered Up!

NEW!
$34.95

A 0309

Korjo® 4xUSB Travel Adaptor

Enough ports for all your portable devices! 2.1A max current shared between 4 USB ports. Includes adaptors for Australian, US, UK and European outlets. 100-240V ac.

Dual USB Mains Charging Adaptor

With pass through 240V socket so you don't lose an outlet! Great for keeping your phone, tablet or MP3 player charged. **M 8892**

VALUE!
$12.95

Buy 2 for $20

Handy Car USB Adaptor

Stay charged up on the road! Max 2A.

HANDY!
$9.95

Buy two for $16

M 8623A

Power up your cup holder

Fitted with dual USB & accessory sockets. 5V 1A USB output.

SAVE 44%
$10

M 8622

SAVE 12%
$29

M 8070

Lowest Price Ever!

240V Power From Your Drink Holder!

Provides 240V power for charging laptops, small tools, lamps, chargers and more! 150W rated (450W surge). Ideal for camping, 12V input. 60mmØ. Modified sine wave.

VALUE!
$7.95

S 4904 2xAAA

VALUE!
$8.95

S 4906 2xAA

Long Life Lithium Batteries

Big brand name performance for a much lower price! These top quality Powerhouse® lithium batteries offer excellent performance in high power devices. Note: not rechargeable.

ALTRONICS
BUILD IT YOURSELF ELECTRONICS CENTRE

Our Build It Yourself Electronics Centres...

» **Balcatta WA:** 7/58 Erindale Rd » **Cannington WA:** 6/ 1326 Albany Hwy
» **Perth WA:** 174 Roe St » **Auburn NSW:** 15 Short St » **Springvale VIC:** 891 Princes Hwy

Build It Yourself Electronics

Digital-Analog Converter Kit

(SC Sept-Nov '09) This professional quality kit will drastically improve the sound output from your DVD player, allowing you to obtain audiophile quality sound from a regular CD/DVD player, set-top box, PVR or computer. Also reduces buzz, hum and signal noise, ensuring your listening experience is top notch. Coaxial or optical inputs. RCA output. 240V mains operation. Includes screened and punch rack case, all components, transformer, PCBs and cabling.

Silicon Chip Studio Series Pre-Amplifier

Audiophile grade, ultra low distortion design.

This brilliant high performance stereo pre-amp offers as good as Class-A performance. Features five ultra low distortion inputs, dual headphone amp, motorised remote volume control and low noise power supply. All presented in a silk screened & machined chassis. Every bit as good as a commercial unit, at a fraction of the cost!

GPS Boat Computer Kit

(SC Oct '10) Tells you exactly where you are - never get lost at sea again. Also shows speed and heading - plus it will navigate you back home - or to that secret fishing spot! It even displays fuel consumption, along with a host of other vital information.

Boost Dynamic Range From Your Microphone

(SC Sept '10) Mini Mic Pre-Amp Kit. Boosts signal levels for better volume from unpowered mics when used with a mixer or PC sound card.

- Suits balanced or unbalanced mics
- Low noise & distortion
- Line level output.
- 5-20VDC input.

LED Musicolour Kit

(SC October '12) Updated Musicolour for LED technology! A continuously changing kaleidoscope of colour changing in time to the music. Controls up to 16 strings of LEDs tuned to individual frequency bands. Great for Christmas lighting or DJ's and parties.

Mini-Maximite Embedded Module

(SC November '11) The 'little brother' of the Maximite kit. Utilising identical software it is designed as an ultra compact intelligent controller. Some assembly required.

Take the 'kick' out of power tools!

(SC July '12) This handy soft starter kit prevents your electric saw, router or other large mains-powered hand tool from kicking when you squeeze the trigger. Ensures a clean accurate cut every time. Max load 10A.

Champion 7W Amp Kit

(SC Jan '13) A fully upgraded version of the old 'Champ Amp'. Delivers up to 7W of peak power with low distortion. It also offers muting and standby control, plus two mixed inputs. All on a tiny board! 4-13.5V dc input.

Real-time Vehicle Datalogging Kit

(SC Dec '08) A do-it-all digital readout for your cars dash. Monitors up to six signals & displays up to 10 values in a scrolling/static readout. Measure values such as fuel injector duty cycle, air/fuel ratio, cabin/engine temp, fuel tank level, battery voltage or many car ECU signals.
Size: 134 x 86mm.

Digital Audio Signal Generator Kit

(SC March '10). With S/PDIF coaxial and optical output - plus dual analog outputs! Incredibly low distortion (typically <0.06%). Sine, square, triangle and sawtooth wave generator. Plus waveform mixing, pulse and sweep modes. Ideal for RMS and music power testing of amps or speakers; testing DACs & crossovers. Requires 4xAA or 9V plugpack.

Get the most from your solar panels with an MPPT charger.

(SC March '12) Delivers optimum charge current to your connected batteries via an in-built 3 stage charging system (bulk, absorption, float). Equalisation feature allows you to ensure all cells in a bank are equally charged. Suitable for charging 12V batteries from nominal 12V panels up to 120W (can be modified to suit 24V systems).
Note: this is MKII version of this kit published in March 2012 issue of Silicon Chip.

Sale Ends July 31st 2013

Altronics Phone 1300 797 007 Fax 1300 789 777

Mail Orders: C/- P.O. Box 8350 Perth Business Centre, W.A. 6849

© Altronics 2013. E&OE. Prices stated herein are only valid for the current month or until stocks run out. All prices include GST and exclude freight and insurance. See latest catalogue for freight rates. All major credit cards accepted.

Resellers:

WESTERN AUSTRALIA

Bunbury	ML Communications	(08) 9721 9800
Esperance	Esperance Comms.	(08) 9071 3344
Geraldton	ML Communications	(08) 9965 7555

VICTORIA

Bairnsdale	Bairnsdale Electrics	(03) 5152 3201
Beaconsfield	Electronic Connections	(03) 9768 9420
Castlemaine	Top End Technology	(03) 5472 1700
Clayton	Rockby Electronics	(03) 9562 8559
Cranbourne	Bourne Electronics	(03) 5996 2755
Croydon	Truscott's Electronic World	(03) 9723 3860
Geelong	Music Workshop	(03) 5221 5844
Healesville	Amazon DVDs Healesville	(03) 5962 2763
Hoppers Crossing	Leading Edge	(03) 9931 0845
Leongatha	Gardner Electronics	(03) 5662 3891
Nunawading	Semtronics	(03) 9873 3555
Preston	Preston Electronics	(03) 9484 0191
Rosebud	AV2PC	(03) 5986 6711
San Remo	Shoretec Elec. Wholesale	(03) 5678 5361
Somerville	AV2PC	(03) 5978 0007
Wodonga	Exact Comp. & Home Ent.	(02) 6056 5746

TASMANIA

Hobart	Active Electronics	(03) 6231 0111
Launceston	Active Electronics	(03) 6334 7333

QUEENSLAND

Bowen Hills	Prime Electronics	(07) 3252 7466
Caloundra	LESC	1300 716 840
Cloncurry	Access Electronics	(07) 4742 2590
Coorparoo	Delsound	(07) 3397 8155
Fortitude Valley	Design Data	(07) 3854 1588
Gold Coast	Prime Electronics	(07) 5531 2599
Hervey Bay	Ultra Music	(07) 4128 2037
Innisfail	Leading Edge Electronics	(07) 4061 6214
Longreach	Access Electronics	(07) 4658 0500
Rockhampton	Access Electronics	(07) 4922 1058
Toowoomba	Michael's Electronics	(07) 4632 9990
Townsville	SOLEX	(07) 4771 4211

NEW SOUTH WALES

Brookvale	Brookvale Electrical Dist.	(02) 9938 4299
Cessnock	Leading Edge Electronics	(02) 4990 5971
Cobar	Cobar Electronics	(02) 6836 2962
Denistquin	Wired Entertainment	(03) 5881 3555
Gloucester	Autolec Gloucester	(02) 6558 1600
Grafton	Downes Electronics	(02) 6642 1911
Griffith	Griffith Systems Plus	(02) 6964 5933
Gunnedah	Protronics	(02) 6742 2110
Lithgow	Leading Edge Electronics	(02) 6352 3333
Nth Richmond	Candle Power Tech.	(02) 4571 4699
Oak Flats	Oak Flats Electronics	(02) 4256 6120
Orange	Fordray Electronics	(02) 6362 9901
Penrith	Penrith Light and Sound	(02) 4733 3333
Port Macquarie	Fettel Comms.	(02) 6581 1341
Strathfield	Chantronics	(02) 9609 7218
Tamworth	Bourke Street Electronics	(02) 6766 4664
Taree	Noeledge Systems Pty Ltd	(02) 6551 3622
Wagga Wagga	Wagga Car Radio	(02) 6925 6111
Waterloo	Herkes Electrical Supplies	(02) 9319 3133
Wetherill Park	Techtron Electronics	(02) 9604 9710
Windang	Mad Electronics	(02) 4297 7373
Wollongong	Lightsounds Wollongong	(02) 4226 1177
Wyong	Coastal Caravan And RV	(02) 4353 1100

SOUTH AUSTRALIA

Adelaide	Actronics	(08) 8212 6212
Brighton	Force Electronics	(08) 8377 0512
Enfield	Actronics	(08) 8349 6340
Findon	Force Electronics	(08) 8347 1188
Kadina	Idyll Hours Hobbies	(08) 8821 2662

NORTHERN TERRITORY

Darwin	Combined Comm. Solutions	(08) 8942 0644

NEW ZEALAND

Christchurch - Riccarton	Global PC	+64 3 3434475
Christchurch - Shirley	Global PC	+64 3 3543333

Please Note: Resellers have to pay the cost of freight and insurance and therefore the range of stocked products & prices charged by individual resellers may vary from our catalogue.

USB PORT VOLTAGE CHECKER

Above: the unit can be used to check for voltage fluctuations when an external USB-powered unit is connected in-line with the voltage checker.

By NICHOLAS VINEN

If you carry valuable data around on a USB flash drive, it's not a good idea to plug it into other people's computers willy-nilly. They could have dead or faulty USB ports and an incorrectly wired USB port can destroy a flash drive. Tragedy! Test it first with this handy USB Port Voltage Checker.

USB DEVICES ARE convenient for many reasons and one of these is that you can walk up to just about any computer anywhere and plug a USB peripheral in. This is most useful for storage devices like flash drives and hard drives but can apply to just about anything.

But unless it's your computer and you know the ports are all working OK, there is the possibility that your treasured USB device will be damaged by a faulty port. This could happen for a few reasons. One is that front-panel USB ports are normally plugged into a USB pin header interface on the computer's motherboard via a multi-core cable and these can be plugged in incorrectly, causing the port supply voltage to be reversed. That could easily damage a connected device. In fact, in this case, damage is likely.

There is also the possibility that the computer's power supply has a poorly regulated 5V rail, giving a port voltage that is too high, too low or fluctuating. This also applies for powered hubs and other devices where a failed plugpack could easily lead to trouble. Port voltages that are too high could also damage a connected device while voltages that are too low (permanently or only when current is being drawn) could lead to erratic device operation.

Well, that's enough about what could go wrong. This checker will show you when a USB port's voltage is in the correct range so you can plug in your flash drive or other device with confidence. You can even leave the unit connected and plug the device in piggy-back style, so you can continue to monitor the supply voltage during operation, to ensure it doesn't fluctuate too much.

The USB Port Checker is just 67 x 17 x 10mm – not much longer than flash drive. It's built on a small double-sided PCB measuring 44 x 17mm and is encapsulated in clear heatshrink tubing for protection. It uses a mixture of through-hole and surface-mount devices to keep it compact.

Circuit description

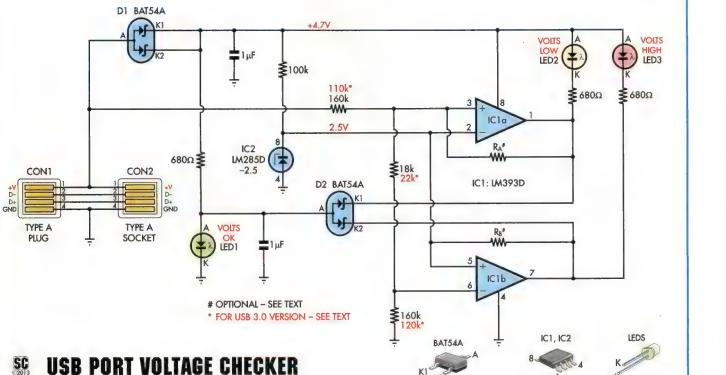
Fig.1 shows the full circuit. The USB plug (CON1) and socket (CON2) – both Type-A – are wired straight through so the function of any USB device connected to CON2 is not affected. The D+ and D- signalling lines are run close together down the middle of the PCB so that the digital data signals are not affected, as well.

Schottky diode D1 rectifies the USB supply voltage so that if the polarity is reversed, nothing happens – no LEDs light, including the green one, so you know something is wrong with the port. This is a dual diode with a common anode connection but we're using them both in parallel.

Why do this? Simply because we need one elsewhere and it's easier to use two identical parts than two different ones.

If all is OK, LED1 (green) is lit and this simply runs off the rectified voltage of around 4.7V with a 680Ω current-limiting resistor. Typical LED current is around (4.7V - 2V) ÷ 680Ω = 4mA.

IC2 is a 2.5V reference "diode" which is actually an integrated circuit



USB PORT VOLTAGE CHECKER

Fig.1: complete circuit of the USB Port Checker. It's based on dual comparator IC1 and voltage reference IC2. If the voltage is OK, green LED1 is lit while yellow LED2 and red LED3 indicate under-voltage and over-voltage respectively. If the supply polarity is reversed or voltage is very low, none of the LEDs light up.

with two pins (well, it has eight but six are unconnected). It is effectively a shunt regulator and it runs off the 4.7V supply via a 100kΩ resistor. That gives it a current of about (4.7V - 2.5V) ÷ 100kΩ = 22µA, with its recommended minimum being 10µA.

One half of dual low-power comparator IC1a compares this 2.5V reference to a divided-down version of the USB supply voltage. This is achieved with a resistive voltage divider comprising two 160kΩ resistors and an 18kΩ resistor. IC1a's inverting input (pin 2) is connected to the 2.5V reference while the voltage at the non-inverting input is at V+ x 0.527 where 0.527 is the divider ratio, calculated as (160kΩ + 18kΩ) ÷ (160kΩ x 2 + 18kΩ).

For USB 2.0, the minimum supply voltage is specified as 4.75V. If we plug this into the formula above, we get 4.75V x 0.527 = 2.5V which is the same as the 2.5V reference it is being compared against. So when the USB supply drops below 4.75V, pin 3 of IC1a goes below 2.5V and IC1a's output switches low, turning on LED2, again with a current of about 4mA.

At the same time, IC1a also turns off green LED1 by pulling its anode low through half of dual-Schottky diode D2. Thus, if the USB voltage is too low, the yellow LED turns on and the green LED turns off.

A 1µF capacitor across LED1 ensures that it is switched off for a minimum period (a few milliseconds) even if there is a brief drop in the USB voltage. That won't be noticeable in isolation but if the USB voltage is dropping below 4.75V often enough, it means that LED1 will either dim or go off entirely.

Note that the PCB has provision for an SMD resistor labelled R_A to add hysteresis for comparator IC1a. However, we don't think it's necessary.

Over-voltage checking

The circuit to detect over-voltage is similar. In this case, comparator IC1b is used, as is the same 2.5V reference voltage from IC2. This time, however, the division ratio is different as IC1b's inverting input is connected to the other end of the 18kΩ resistor. That means the formula to calculate the comparator threshold is V+ x 0.473, which means the upper threshold is a little above 5.25V.

Again we can check this by doing the calculation: 5.25V x 0.473 = 2.48V. So red LED3 will turn on if the supply voltage goes much over 5.25V. As with IC1a, IC1b's output going low also turns off LED1, via the other half of dual-diode D2.

Pads for a hysteresis resistor (R_B) are supplied but as before, we don't think it's necessary. If R_B is fitted, its value will need to be chosen carefully – see below.

USB 3.0 support

The 4.75-5.25V (ie, 5V±5%) USB supply range is from the USB 2.0 specification. The newer USB 3.0 specification allows for more current to be drawn by USB devices and as such, also allows a wider variation in supply voltage, ie, 4.45-5.25V. While we don't think it will happen very often, this means that with a USB 3.0 port, the under-voltage indication (ie, yellow LED lit) could occur while operating within specifications.

If you want to accommodate this, you can do so by changing the divider resistor values, ie, use the values shown in red on the circuit diagram. The divider ratios then become 0.563 and 0.476, giving an upper threshold of 2.5V ÷ 0.476 = 5.25V and a lower threshold of 4.44V.

Accuracy

The 2.5V version of the LM285 voltage reference has a tolerance of ±1.5%

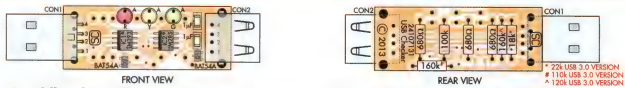


Fig.2: follow these PCB overlay diagrams to assemble the USB Port Checker. The SMD parts (ICs, diodes and capacitors) all go on the top side along with the LEDs and connectors, while the resistors are all fitted on the bottom side. The two empty pads on the bottom are for optional hysteresis setting resistors.

These photos show the front & rear of the completed PCB. Take care soldering in the SMDs and check that the diodes & ICs are correctly orientated. You can remove solder bridges across the IC pins using solder wick.

which translates into an error of about ±0.08V referenced to the USB supply voltage. Taking into account resistor tolerances and variations in the forward voltage of D1, the maximum error could be more than that. There is also a roughly +5-10mV error due to the input bias current of IC1a and IC2a flowing through the divider network.

An error of ±0.1V would be fairly significant compared to the ±0.25V specification for the USB 2.0 supply but this is a worst case figure and without taking any special care, our prototype's thresholds measured very close to what we calculated above. You would be unlucky to build one of these and find it had more than ±0.05V error.

Our (randomly chosen) LM285 measured 2.4946V which is an error of just -0.22%. One easy way to check the accuracy of your voltage reference IC is to use a DMM to measure the voltage across its lower-left and upper-right pins while power is applied. If your reading is much lower than ours, try reducing the value of the 100kΩ resistor feeding it (eg, to 10kΩ) as a higher operating current should (slightly) increase the reference voltage.

Construction

Fig.2 shows the assembly details. Begin the construction by fitting the SMD components to the PCB, which is coded 24107131. Install the two ICs first. Figure out which is which and then locate pin 1 which is normally indicated by a divot or dot in the corner of the plastic package. It could also be indicated by a stripe along the top of the IC (between pins 1 & 8) or by a bevelled edge which will be on the pin 1 side.

Put a little solder on one of the IC pads then place the chip in the correct position, with pin 1 at upper-left. While heating that solder, slide it into position. You can re-heat the solder and adjust it if necessary, then solder the rest of the pins. Finally, add a little solder to the first pin you soldered, to refresh it.

If any pins are bridged, you can clear them using solder wick although often all that's required is to slide the soldering iron tip between the pins and then back again (assuming it's fine enough).

Now fit the two SMD dual diodes. Their orientation should be obvious as long as they are not upside-down, ie, solder them with their leads touching the PCB. Then mount the two ceramic capacitors, again using a similar technique but make sure you wait a bit between soldering one pad and the other to ensure the first joint has solidified before making the second.

The through-hole components can then go in. The resistors go on the other side to the SMDs (check each one with a DMM before fitting it). The three LEDs go on the same side as the SMDs, with their anodes to the edge of the board.

Finish up by fitting the two USB connectors – the socket (CON2) is optional but recommended. Ensure that their mounting tabs are fully pushed into the corresponding holes on the PCB before soldering them and then finally the signal pins.

You can test it by simply plugging it into a known-good USB port; the green LED should light while the others should remain off. If you have a variable voltage DC supply, you can wire it up across the USB pins (using a spare plug perhaps) and then vary it between 4.5V and 5.5V to check that the yellow and red LEDs come on at the correct voltages.

Once you're satisfied, slide some clear heatshrink tubing over the unit and shrink it down.

Hysteresis

As noted above, you probably don't need to add resistors for comparator hysteresis. The advantage of hysteresis is that a brief excursion beyond one of the thresholds is more likely to cause

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	160kΩ	brown blue yellow brown	brown blue black orange brown
❑	1	120kΩ	brown red yellow brown	brown red black orange brown
❑	1	110kΩ	brown brown yellow brown	brown brown black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	1	18kΩ	brown grey orange brown	brown grey black red brown
❑	3	680Ω	blue grey brown brown	blue grey black black brown

USB Port Polarity: A Simple Approach

This project was inspired by reader Bruce Pierson, who sent in details of a simple design to check USB port supply polarity. As you can see, his design consists of just a USB plug (surface-mounting type), a LED and a resistor, all soldered to some Veroboard and housed in the plastic case from a defunct flash drive.

If all you want to do is check the supply polarity then this is not a bad idea and it's certainly much less complicated than our approach. But obviously, it won't give you much clue as to whether the bus voltage is too low or too high unless it is grossly so and you will have no way of monitoring the bus voltage on that port while another device is connected.

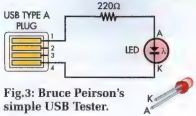


Fig.3: Bruce Peirson's simple USB Tester.

the LED to come on and stay on rather than flicker so briefly that you may not notice it. In practice, what happens as the bus voltage crosses the threshold is that one LED appears to fade in while the other fades out, due to rapid switching between them.

If you decide to add hysteresis, choosing a value for R_A is fairly simple. With R_A = 10MΩ, once the supply voltage drops below the lower voltage of 4.75V, this threshold is changed to about 4.77V by the fact that R_A is effectively in parallel with the lower part of the voltage divider. In other words, it will give about 20mV of hysteresis.

A lower value resistor will give proportionally more hysteresis. Much more than 100mV of hysteresis is probably not desirable, giving a minimum value of 2.2MΩ or so. Note that fitting R_A will also shift the lower threshold needed to turn on LED2 as well, but only very slightly.

Choosing a value for R_B is more tricky, because when IC1b's output is low, it is effectively in parallel with IC2 and we must also consider that some or all of IC1b's input bias current will flow through it. A sensible value would be around 91kΩ. This forms a divider with the 100kΩ resistor supplying current to IC2 such that the reference voltage should be pulled down to about 2.35V when IC1b's output is low, providing around 0.3V of hysteresis for the lower supply threshold.

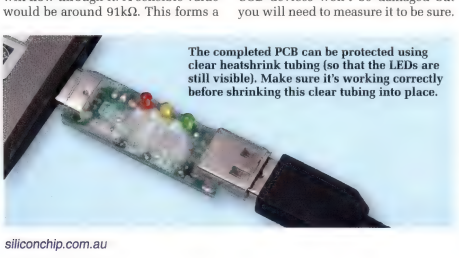
We haven't tried this though and obviously, if you change the 100kΩ resistor value you will need to scale R_B similarly.

The pads for R_A and R_B are designed to accept metric 3216 or imperial 1206-sized SMD chip resistors.

Using it

Simply plug it into a USB port. If it shows a green light, it's OK. You can then either unplug the checker and connect your USB device or you can simply leave it in and plug your device into its socket. It should not affect operation.

If no LEDs light, then either the port is dead or its supply polarity is reversed. Either way, we don't recommend plugging anything else into that port before you check it out. Similarly, if you get a red LED, be careful – the voltage may be just a touch high. Most USB devices won't be damaged but you will need to measure it to be sure.



The completed PCB can be protected using clear heatshrink tubing (so that the LEDs are still visible). Make sure it's working correctly before shrinking this clear tubing into place.

Parts List

1 double-sided PCB with plated-through holes, code 24107131, 44 x 17mm
1 PCB-mount USB type A plug (CON1) (element14 2067044 or 1696544)
1 PCB-mount USB type A socket (CON2) (element14 1696534, Jaycar PS0916, Altronics P1300) – optional, see text
1 60mm length 16mm-diameter clear heatshrink tubing

Semiconductors

1 LM393D dual low-power comparator (IC1) [SOIC-8] (element14 4380563 or 2294229)
1 LM285D-2.5 micropower voltage reference (IC2) [SOIC-8] (element14 8389195)
2 BAT54A dual common-anode Schottky diodes (D1-D2) [SOT-23] (element14 1081191)
1 green 3mm LED (LED1)
1 yellow 3mm LED (LED2)
1 red 3mm LED (LED3)

Capacitors

2 1μF 16V SMD ceramic [3216/1206] (element14 1683655, Altronics R9950)

Resistors (0.25W, 1%)

2 160kΩ^ 1 22kΩ*
1 120kΩ* 1 18kΩ^
1 110kΩ* 3 680Ω
1 100kΩ

* for USB 3.0-compatible version
^ for USB 2.0-compatible version

Note: a kit for this project is available from Jaycar, Cat. KC-5522.

If the yellow LED is lit, the low voltage is unlikely to damage anything but your USB device may not get enough power to operate properly. Note that if the bus voltage is very low, it's possible that the red LED could also light (dimly).

Some chargers which use USB ports can put out as much as 6V. This is most common with high-current chargers in the 2-3A range, such as those for tablet computers. We believe that this is an attempt to get the maximum current through the USB cable. While most devices will tolerate 6V, some could overheat and in theory damage could occur, so take care plugging anything not designed for these chargers into them. SC

PRODUCT SHOWCASE

Discone Antennas? Icom DO still have 'em!

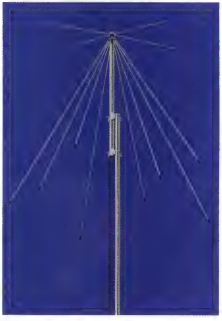
In the "Software Defined Radio" article in the May 2013 issue, Jim Rowe bemoaned that fact that a discone antenna, ideal for use with the SDR, was "originally sold for about $100 but Icom don't appear to sell them anymore."

"Yes we do!" replied Icom Australia almost as soon as the May issue appeared. In fact, they sent us a picture of their current model discone (cat no AH-8000) and a list of specs (opposite).

Jim Rowe could be forgiven because a search of the Icom website failed to find much detail or description. But Icom assure as they are available.

This discone would appear to be just about perfect for anyone interested in experimenting with the TV Dongle and software-defined radio as detailed in that article.

So if you're in the market for a discone antenna, check out Icom Australia's website for an extensive list of dealers.



Basic Specs

Receive frequencies:	100-3300MHz
Gain:	3dBi (max)
Connector:	Type N(50Ω nom)
Height:	936mm
Wind resistance:	50m/s.

Contact:
Icom Australia Pty Ltd
Unit 1, 103 Garden Rd, Clayton, Vic 3168
Tel: (03) 9549 7500 **Fax:** (03) 9549 7505
Website: **www.icom.net.au**

Extra Low Voltage DC power distribution equipment

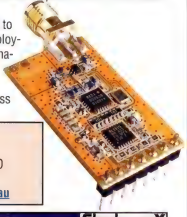
Quick Thinking Pty Ltd, a Melbourne business inventing new products, has released a range of DC power distribution wall plates, cables and adaptors, to allow ELV, particularly 12V DC, to be reticulated. The outlets allow a variety of low power loads, up to 15A, to be connected: modems, clocks, games, TVs. Cables are available for trickle charging 12V batteries, connecting 1.5V wall clocks and 9V smoke detectors, thus eliminating all battery and plugpack powered loads from the grid. Instead they can be cabled to a 12V battery charged by a solar panel. USB outlets released soon. Licensees are being sought.

Contact:
Quick Thinking Pty Ltd
3 Deavey Court, Altona, Vic 3018
Tel: 0499 773 400
Website: **www.quickthinking.com.au**

DORJI DRF4463D20 Medium Power ISM RF Transceiver from Wiltronics

This new data radio modem combines the advantages of the Dorji DRF4432D20 and DRF1212D10 modules. It features GFSK modulation, multi-channel operation, high bandwidth efficiency and anti-blocking performance. Operating in the 433MHz ISM frequency band with up to 40Kbps RF data rate, the module can be configured to seven baud rates and seven RF power outputs in 3dBm increments up to 20dBm.

The module can be configured to work in four different modes employing a range of power saving mechanisms, making the DRF4463D20 ideal for battery powered operation, with a standby current of less than 2.5μA being achievable.



Contact:
Wiltronics
PO Box 4043, Alfredton Vic 3350
Tel: (03) 5334 2513
Website: **www.wiltronics.com.au**

See the Latest in Electronics Products & Technology at ElectroneX!

ElectroneX – The Electronics Design & Assembly Expo returns to Melbourne on 11-12 September this year at Melbourne Park Function Centre. This specialised event is the major focal point for the electronics industry in Australia and is designed to help professionals across a vast array of industry sectors to stay in touch with the latest electronics technology developments for systems integration and production electronics.

Design, electronic & electrical engineers, OEM, scientific, IT and communications professionals and service technicians are invited to attend the event where they will find the latest technology driving future product & system developments.

ElectroneX comprises a major trade show with over 80 companies showcasing and demonstrating the latest new product releases for industry, scientific and commercial applications. The SMCBA – Electronics Design & Manufacture Conference is being held in conjunction with the exhibition.

This year's conference will feature several highly acclaimed international presenters and deliver a wealth of information on electronics design and manufacture but will also feature new streams on Embedded Systems and New Product Development.

For further information and free trade registration for the expo visit www.electronex.com.au.

Found an RF chip that you wish to use in a proof of concept system?

Manufacturer evaluation boards are great for evaluating the performance of individual devices but a lack of shielding can mean that they do not perform as expected when used to create prototype systems. Evaluation boards also often require additional support such as multiple power supplies and this adds to the difficulty of using them.

Packaging the RF chip in a shielded housing with power supply, support circuitry and connectors permits the design engineer to easily construct a prototype to check system operation.

By using a number of pre-designed circuit elements and housings combined with RF design capability, Syndetic can quickly design and economically manufacture a module containing the required RF chip.

The module is supplied fully characterised with test results.This allows the design engineer to calibrate simulated results against measured results in order to get a better idea of eventual system performance.

Contact:
Syndetic Pty Ltd
4/20 Cansdale St, Yeronga Qld 4104
Tel: (07) 3255 8900 **Fax:** (07) 3255 8901
Website: **www.syndetic.com.au**

Maximite-compatible DTX series embedded module

The concept of using modules has a great support worldwide but the new DTX2-4105C module takes embedded development to a whole new level – chip-style modules. It has been explicitly designed for inclusion into other products instead of early educational activities only. Its standard PLCC68 package allows the use of mass available IC sockets for easier mounting on the spot, or it can also be assembled directly onto the user's printed circuit board.

This new module brings a popular modern hobby computer into a small chip, which can be directly used in the user's custom equipment. The compatibility with the Maximite computer is a foundation that opens the door towards simple development, but this time in the world of embedded devices.

Just imagine a small electronic circuit, which you could connect to via a standard USB cable and a terminal, write your software, debug it, use file system, and many more functions, currently available with the MMBasic – all that on the release revision of your board! This module has been made to save time in the writing of low-level support drivers and all those layers of software under the actual application.

Contact:
Dimitech
435-437 Nepean Hwy, Frankston Vic 3199
Tel: (03) 9016 8919 **Fax:** (03) 9932 2709
email: **www.dimitech.com**

Jaycar's Mozzie Zapper is based on real science!

You might think that mosqitoes disappear during winter – but don't you believe it. They are around all year and are more than capable of spreading several nasty diseases despite the cold weather. So it pays to get rid of them any time of the year – and when summer finally returns, you will really enjoy it!

We've all seen those ultrasonic mozzie zappers that are supposed to attract the little blighters and despatch them to mozzie heaven . . . but it's been proven that they don't work! Neither do those that rely purely on UV light.

On the other hand, this new Photocatalyst Insect Trap from Jaycar is based on the proven science that mozzies are attracted to humans mainly by the carbon dioxide (CO_2) that we exhale. So it produces CO_2 to make them think they are getting a feed!

This trap lures the little pests using a tripartite system – heat and UV-A light are produced by a BL bulbm while CO_2 is produced when near-ultraviolet rays are radiated into Titanium Dioxide (TiO_2).

Mosquitoes enter the trap through the capture windows on the upper portion and are drawn down by suction from the fan into the capture net below. Once in the net, they cannot escape. It's safe, effective, quiet and uses little energy.

No claims are made regarding other annoying insects but we would be surprised to find that it didn't work well with them too – the ones that are attracted purely by UV light (they think it's a BIG flower!).

It's designed to be used indoors or under shelter outdoors and operates from 12V DC @ 1A so it's also ideal for campers and caravanners via a suitable 12V battery and lead (not included). A 230-12V 1A plugpack is included for home use.

It's not tiny, measuring about 240mm high and about the same diameter. A ring is provided for chain hanging.

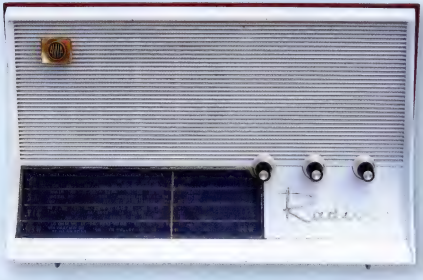
It's priced at $49.95 (Cat YS-5516) and is available from all Jaycar outlets. SC

Contact:
Jaycar Electronics (all stores)
PO Box 107, Rydalmere NSW 2116
Order Tel: 1800 022 888 **Fax:** (02) 8832 3188
Website: **www.jaycar.com.au**

Vintage Radio

By Rodney Champness, VK3UG

Restoring an AWA B15 AM broadcast receiver



Housed in a unique plastic case with a concave front panel, the AWA B15 Radiola is a 5-valve set that's easy to troubleshoot and restore. This particular set had several unusual faults though.

THE AWA B15 is a typical 5-valve mantel receiver from the 1960s. Designed towards the end of the valve era, it's a conventional superhet design with a converter stage, an IF (intermediate frequency) amplifier, a detector with AGC (automatic gain control), two stages of audio amplification and a power supply using a valve rectifier.

For many manufacturers of that era, marketing such receivers often came down to cabinet styling. A couple of unusual cabinet styles that are now highly sought after were used with the Healing "scales" and the Astor "football" receivers and these now fetch quite high prices on ebay and other auction sites. Some sets even came in different colours like green or blue or with different coloured flecks in the finish, the cost of such radios now varying according to rarity.

The AWA B15 is not quite in this league. It has a rather unique concave front panel which looks interesting but it doesn't generate as much excitement as the Healing "scales" and the Astor "football" receivers. That's not to say that the B15 and many other receivers of the era don't look good. They do but they don't fall into the "must have" category.

That said, I have two such sets in my collection and I described the restoration of one of these sets back in the June 1999 issue of SILICON CHIP.

Another restoration

Just recently, I was asked to restore another one of these sets. Its owner claimed that it only required a new dial cord (the original had broken) and a new dial lamp. Apart from that, he thought that the set was in working order.

Despite this, I gave him an estimate as to what I thought it would cost to completely overhaul the receiver. He was rather taken aback at the amount but I explained to him that, based on my experience, it wouldn't end with the dial cord and lamp. Instead, lots of other components (such as capacitors) would also have to be replaced, especially as this particular set had been sitting in a shed for many years exposed to dust, moisture, mice, moths and various insects.

My policy is that any receiver I work on must be returned to its owner in good condition. That means it must be reliable, it must work correctly and the cabinet must be clean and intact. And of course, it must be safe to use.

Some restorers only give a "footpath warranty", whereby the set is only guaranteed to operate until such time as it leaves the property. On the other hand, I'm prepared to give several months' warranty on the work I do and the parts I replace. However, as I always explain to the customer, I cannot give a warranty on any other parts in the set as they may be up to 90 years old.

I've yet to come across anyone who doesn't accept this as being reasonable. And because I'm always careful to check and test the set thoroughly, I rarely have a return due to a fault.

In this case, the owner accepted the quote and left the set with me. Fortunately, the B15 is a set that's easy to work on – the chassis is easy to remove and all parts under the chassis are easy to access.

Circuit details

Fig.1 shows the circuit details of the AWA B15. It uses a fairly standard 5-valve line-up, a ferrite rod antenna and 455kHz IF stages.

As shown, an external antenna

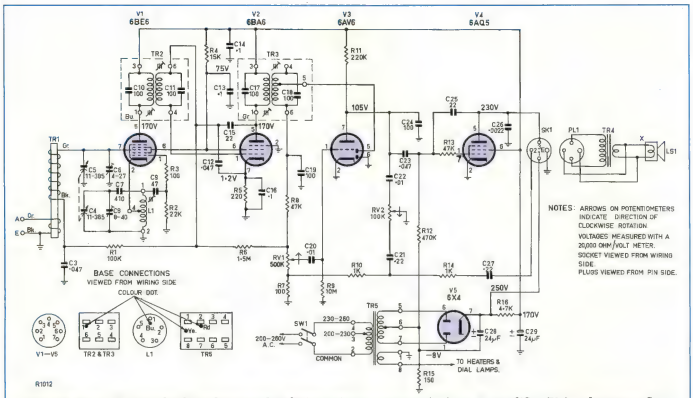
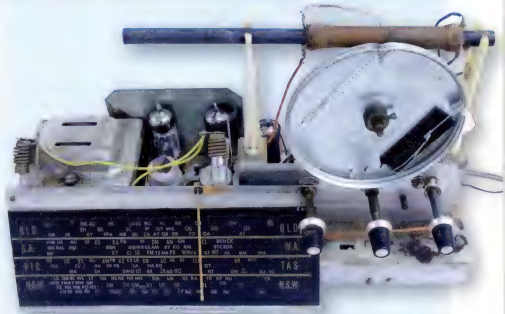


Fig. 1: the circuit is a standard 5-valve superhet design using a converter (V1), an IF amplifier (V2), a detector & first audio stage (V3), an audio output stage V4 and a full-wave rectifier (V5).

and earth (if used) are connected to a "link" winding on the ferrite rod and this is inductively coupled to the main tuned winding on the ferrite rod. These windings are on a former that can be slid along the rod to achieve best performance at the low-frequency end of the tuning range. Note too that the ferrite rod is mounted high on the chassis, so care needs to be taken when turning the set upside down for servicing to ensure the rod isn't damaged.

The converter valve (V1) is a 6BE6 pentagrid and the oscillator coil (L1) is wired into the cathode circuit, with the cathode being connected to a tap part way up the coil. The resulting 455kHz signal from this converter stage appears on the anode and is fed via 455kHz IF transformer TR2 to the grid of V2 (a 6BA6) where it is amplified and fed to the second IF transformer (TR3).

Following TR3, the signal goes to a detector diode in V3 (a 6AV6) and the resulting audio signal filtered by C19 is fed to volume control RV1 via resistor R8. The audio signal at RV1's wiper is then fed to the grid of the 6AV6 where it is amplified and then fed via an RC network (C23 & R13) to the grid of V4, a 6AQ5 audio output stage. This in turn drives the loudspeaker via speaker transformer TR4.



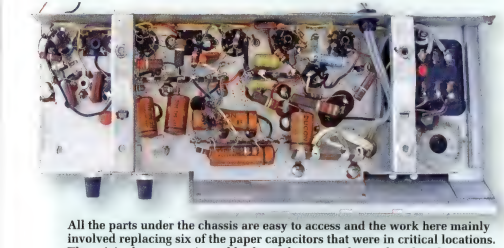
The AWA B15's chassis is easily removed from the cabinet and all parts are readily accessible. This photo shows the unit with it new dial cord in place.

Only simple AGC is applied in this set, with the DC voltage developed across RV1 and R7 applied via R6 and R1 to the converter and IF amplifier stages (V1 and V2). The IF stage is neutralised by the combination of C15, C12 and (to a lesser extent) C16.

The audio output stage includes negative feedback. This feedback signal is derived from transformer TR4's secondary and applied to the top of R7 via C27, R14 and R10. Bias for V4 is derived from the voltage across R15, the back-bias arrangement in the power supply.

Finally, the power supply uses a conventional mains transformer and a 6X4 full-wave rectifier to derive the HT rail. This is filtered by C28, R16 and C29. A separate 6.3V secondary

Despite its age, the AWA B15's chassis was still in good condition, although some corrosion was evident. The antenna coil former hid a break in the ferrite rod which made the set rather insensitive.



All the parts under the chassis are easy to access and the work here mainly involved replacing six of the paper capacitors that were in critical locations. The original 2-core mains cable shown here was also replaced with a 3-core cable so that the chassis could be earthed.

winding on the transformer is used to power the valve heaters and the dial lamps.

Mechanical restoration

I didn't spend a lot of time on the mechanical restoration, as the owner is quite capable of doing some of this and wanted to keep the cost down. As a result, I gave the chassis a quick clean with a kerosene soaked rag, which got the worst of the muck off and left a film of oil on both the chassis itself and the transformer metalwork.

That done, I turned my attention to the broken dial cord. Most people don't like re-stringing dial mechanisms and often find it difficult to work out the layout. Of course, many service sheets show how the dial-cord is run but AWA didn't do that with this set.

Fortunately, I didn't have to waste time figuring it out for myself. Instead, it was just a matter of quickly checking the arrangement in my own B15 set. The dial cord installation subsequently went without a hitch, after which I oiled all the pulleys and the bearings on the tuning gang. I also lightly smeared the dial pointer slide with grease so that it operated smoothly.

The blown dial globe was then replaced and the valve socket pins sprayed with Inox (a contact cleaner/lubricant) to eliminate any contact resistance that may have developed during the set's many years of storage in less than ideal conditions.

Initial tests

My next step was to test the power transformer using a high-voltage insulation tester. The tester I use is a SILICON CHIP design and has a 1000V output. The transformer is tested by measuring the resistance between each side of the transformer primary and chassis.

In this set, the leakage resistance was initially around 50MΩ which is a little on the low side. This is basically the leakage resistance from the mains leads to the transformer frame, heater winding and the secondary winding.

Because the set had been stored in a shed for some time, it was probable that the transformer has absorbed moisture over the years. Accordingly, I replaced the set's original 2-core power lead with a 3-core lead so that the chassis could be earthed, then removed all the valves and applied power. I let it run for several hours, then re-checked the transformer's leakage resistance.

It had climbed to around 100MΩ which is quite a satisfactory figure and indicated that the transformer had "dried out".

At this stage, the transformer was only slightly warm to touch. The AC voltages between pins 5 & 6 and pins 6 & 7 of the transformer (ie, on either side of the centre-tapped HT winding) were then checked. They were identical, which is how they should be. The voltage across the 6.3V winding (between pins 1 and 8) was slightly higher than 6.3V but that's only to be expected when it's unloaded (ie, with the valves removed). In fact, in many sets, it can be as high as 7V unloaded.

Having verified that the transformer was OK, my next step was to test and replace any paper capacitors in critical positions in the receiver (ie, in locations where low leakage is critical). I ended up replacing C3, C12, C20, C22, C23 & C26. The remaining paper capacitors were in low-impedance circuits where leakage is not critical and were left in circuit.

For example, C16 (in parallel with a 220Ω resistor in V2's cathode circuit) could have an electrical leakage as low as around 2kΩ before upsetting the operation of the IF amplifier stage. Even quite leaky capacitors will generally have a leakage resistance of more than 1MΩ, so it's not a problem in this situation.

In this set and in others of the same era, low-voltage paper capacitors had a minimum voltage rating of 200V. However, C3, C12 & C20 were all re-

placed with 50V ceramic capacitors, since the voltage across each of these capacitors is unlikely to exceed 20V.

By the way, it's not always necessary to substitute a capacitor with the exact same value, provided it isn't too different. For example, if the original circuit used (say) a 10nF (0.01µF) capacitor as an audio coupler, substituting a value as high as 22nF or as low as 6.8nF would generally have no apparent difference on the performance.

Capacitor C26 isn't critical as far as leakage is concerned but it was replaced because many capacitors in this position go short circuit. If it's connected from the plate of the output valve to the screen grid, then it's not a critical failure (although the set will stop working). However, when it's connected between the plate and earth as it is here, the speaker transformer can burn out if the capacitor goes short circuit.

In this circuit, it has 230V DC across it to which is added the audio voltage which, if the valve is never cut off, can rise to a peak of around double the DC voltage – 460V in this case. And it can rise considerably higher than this if the valve is suddenly driven into cut-off by the input signal at its grid. For this reason, this capacitor is usually rated at 600V DC.

Modification

A small modification can be made to B15 sets to make them slightly more sensitive and more stable. While the circuitry from the detector onwards is supposedly only involved in amplifying the audio signal, this is not strictly true as it also amplifies the 455kHz IF. There isn't a great deal of IF amplification but it is enough for a significant amount of the IF signal to appear at the plate of the audio output valve.

This signal is radiated and feeds back into the front end of the set where it can cause problems. However, adding a 47pF capacitor between the junction of R6 & R8 and the chassis and another from pin 1 (or 7) of the 6AQ5 output valve to the chassis, reduces this unwanted IF signal at V4's plate by 20-30dB. In fact, this simple modification will benefit most domestic valve AM radio receivers.

Other parts

A quick check with a digital multimeter (DMM) showed that all the resistors were within tolerance, so no replacements were required. In addition, the electrolytic capacitors looked to be in good condition but running the set would prove this one way or the other.

Initially, I simply used my DMM (set to a high ohms range) to check the resistance between the positive terminal of the first electrolytic and the chassis. This showed that there was an initial low-value resistance to earth but this quickly climbed to quite a high value. That meant that the electrolytic capacitors had had some capacitance and that there were no obvious shorts to earth.

Those checks completed, I plugged the rectifier valve in but left the other valves out for the time being. I then applied power to the set while monitoring the voltage across the electrolytic capacitors and checking to ensure that nothing untoward was happening inside the rectifier.

No faults showed up in the rectifier and as soon as the HT voltage started to rise, I switched the set off. I then waited for the capacitors to discharge and the powered the set up again for a short time, this time letting the HT

Radio, Television & Hobbies: the COMPLETE archive on DVD

This remarkable collection of PDFs ***covers every issue*** of R & H, as it was known from the beginning (April 1939 – price sixpence!) right through to the final edition of R, TV & H in March 1965, before it disappeared forever with the change of name to EA.

For the first time ever, complete and in one handy DVD, every article and every issue is covered.

If you're an old timer (or even young timer!) into vintage radio, it doesn't get much more vintage than this. If you're a student of history, this archive gives an extraordinary insight into the amazing breakthroughs made in radio and electronics technology following the war years.

And speaking of the war years, R & H had some of the best propaganda imaginable! Even if you're just an electronics dabbler, there's something here to interest you.

- **Every issue individually archived, by month and year**
- **Complete with index for each year**
- **A must-have for everyone interested in electronics**

Please note: this archive is in PDF format on DVD for PC. Your computer will need a DVD-ROM or DVD-recorder (not a CD!) and Acrobat Reader 6 or above (free download) to enable you to view this archive. This DVD is NOT playable through a standard A/V-type DVD player.

ONLY $62.00 +$10.00 P&P

Exclusive to SILICON CHIP

HERE'S HOW TO ORDER YOUR COPY:

BY PHONE:* (02) 9939 3295 9-5 Mon-Fri

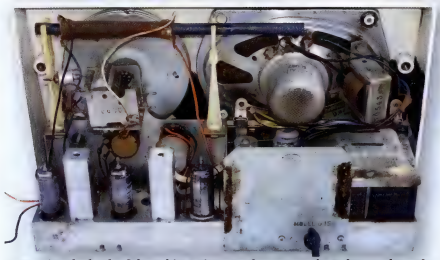
BY FAX:# (02) 9939 2648 24 Hours 7 Days

BY EMAIL:# silcon@siliconchip.com.au 24 Hours 7 Days

BY MAIL:# PO Box 139, Collaroy NSW 2097

BY INTERNET:* siliconchip.com.au 24 Hours 7 Days

* Please have your credit card handy! # Don't forget to include your name, address, phone no and credit card details. ^ You will be prompted for required information



Removing the back of the cabinet gives good access to the valves and to other parts on the top of the chassis. The original loudspeaker still worked but foreign matter had found its way into the voice coil assembly and it had to be replaced to improve the sound quality.

voltage rise a little further. After repeating this procedure several times, I found that the electrolytics now discharged quite slowly, which meant they had quite good capacitance and did not have excessive leakage.

This procedure effectively reforms the electrolytic capacitors, so that they function normally after being left unused for many years. In this case, the capacitors proved to be OK but if they had discharged quite quickly after switch-off, they would have had to have been replaced.

This test also proved that there were no shorts on the HT line due to component breakdown under high voltage.

The speaker and speaker transformer were tested next, although it's usually best to test these parts earlier in the restoration process. The test itself is quite simple – select a low-ohms range on a moving coil multimeter and connect it across the primary of the speaker transformer. When that was done, there was a healthy click from the loudspeaker which indicated that both it and the transformer were OK.

Mains lead

As mentioned earlier, the original 2-core mains lead was replaced with a 3-core mains cable so that the chassis could be earthed. This new cable was securely clamped into position using the existing through-hole cord clamp grommet.

Tracking the gremlins

At this stage, the other four valves were inserted into their sockets, and the set switched on. I then connected the negative lead of my multimeter to the chassis via a clip lead and proceeded to check all the relevant voltages in the set to see how they corresponded to the published figures.

As I did so, the set started operating and stations could be heard at low volume as I tuned across the dial. All voltages were reasonably close to the published figure except for the bias on the 6AQ5 – it was only about -5V instead of -8V, indicating that one or more valves weren't drawing as much current as they should.

At this point, the set suddenly stopped but it could be made to sometimes come on briefly if the chassis was jarred or by moving the 6AQ5 in its socket. A quick check of the voltages around the set soon revealed that the 6AQ5's grid was at +146V, the same as the screen.

This indicated that the grid and screen had shorted together and so the valve was replaced. And that fixed the problem; the bias voltage was now correct and the audio output had significantly improved. The internal intermittent short had obviously caused the faulty valve to draw more current than normal and it had lost most of its cathode emission.

After running the set for half an hour or so, I turned it off and carefully felt all the capacitors that I hadn't replaced, to see if they were hot. Any undue temperature increase can indicate excessive electrical leakage, which means that the capacitor would have to be replaced. In this case, the only ones at all warm were the electrolytic capacitors and this was because they physically are located close to the 6AQ5 and 6X4 valves. In short, their locations are not the best, which is a bit of a design failure in this set.

By now, the set was now operating reasonably well, although its sensitivity was lower than I expected and there was some buzz in the sound at high volume. To get to the bottom of this, I first aligned the two IF transformers (TR2 & TR3) and but this gave only a slight boost to the performance.

Next, I turned my attention to the oscillator circuit. I adjusted the dial pointer on the scale and found that the oscillator circuit was almost perfect across the band. It required only a small amount of tweaking to tune it correctly.

Finally, I took a look at the antenna circuit and found that this tuned to an apparent peak at the low-frequency end of the dial as I slid the coil along the ferrite. However, the trimmer capacitor adjustment at the high-frequency end of the dial didn't end up where I would expect it to be for best performance.

Broken ferrite rod

Although all the tuning adjustments appeared to be working as they should, the set's performance was still lacking. Physically, all looked well with the loop-stick antenna but it was as if the coil didn't have enough inductance. Eventually, I decided to slip the ferrite rod out of the coil former for a closer look. When I did this, half the rod stayed inside the coil – it had broken in two inside the coil former at some stage in the past!

Broken ferrite rods can be repaired by gluing the pieces together. To do this, I laid the two parts on a piece of Glad Wrap on the workbench, then put some super glue on the ends, pushed them together and wrapped the Glad Wrap partly over the rod. I then placed a ruler along the side where I had wrapped the Glad Wrap to ensure that the rod was straight in all directions.

Once the joint was dry, I added some more glue to make the join more permanent. This was then allowed to dry, after which the excess glue was scraped off and the rod reinserted into the coil former. The antenna coil was then adjusted at the low-frequency

end of the dial for best reception, while the antenna trimmer was adjusted for best performance at the high-frequency end.

As expected, the AWA B15 was now performing like it should, with quite good sensitivity – hardly surprising since the ferrite rod antenna was now picking up much more signal. And with an outside antenna and earth connected, the set now really performs.

So if a set lacks sensitivity for no apparent reason and it has a ferrite rod antenna, always check that the rod hasn't broken inside the coil former.

Fixing the noise

Both the volume and tone controls were noisy so each was given a good spray of Inox to get rid of any muck that was adhering to the tracks. That fixed that problem but I wasn't happy with the quality of the sound from the speaker.

By gently pressing on the speaker cone, I could feel voice coil grating against dust and other debris. As a result, I removed the speaker and peeled back the felt cover over the centre of the speaker so that I could take a look inside.

There was quite a bit of dust and some rather sharp grains of abrasive material in there. This was removed but foreign material was still present in other sections of the voice coil/magnet assembly. In the end, there was nothing for it but to replace the speaker.

As shown in the photos, the speaker is a special type with large mounting holes that go over plastic spigots on the rear of the front panel. However, as luck would have it, I just happened to have a spare on hand. It had been salvaged from an identical receiver with a burnt-out power transformer some years ago and I had saved the ferrite-rod antenna as well.

The new speaker worked perfectly and I could have also substituted the ferrite rod if the original had been beyond repair.

The lesson here is that old sets not worth restoring can often be a very useful source of bits and pieces when restoring another receiver. However, if you dismantle an old set, always be sure to clearly mark the parts and, if necessary, mark how they are connected. For example, IF transformers have primary and secondary windings and the pin connections can vary from one type to another.

With the restoration now completed, the set was run for several hours to make sure there were no other gremlins lurking in the works. This is always a good idea because many intermittent faults are heat-sensitive and will only show up after a period of prolonged operation. In this case, the AWA B15 passed with flying colours and was eventually returned to its owner.

Summary

Restoring this set was quite straightforward, even though there were some unusual faults, ie, the short in the 6AQ5 valve, the broken antenna rod and the damaged speaker. It's an easy set to work on, with good access to all parts, and the restored set works quite well.

There was also an element of luck in the restoration in that I had a spare loudspeaker from a junked identical set. Keeping the critical parts from junked sets sure pays off when it comes to restoring old radio receivers. SC

The faulty loudspeaker was replaced with an identical unit salvaged from another B15 chassis that was unrepairable.

SILICON CHIP .com.au/shop ONLINESHOP

Looking for a specialised component to build that latest and greatest *Silicon Chip* project? Maybe it's the PCB you're after. Or a pre-programmed micro. Or some other hard-to-get "bit". The chances are they are available direct from the ***Silicon Chip* ONLINESHOP**.

As a service to readers, ***Silicon Chip*** has established the **ONLINESHOP**. No, we're not going into opposition with your normal suppliers – this is a direct response to requests from readers who have found difficulty in obtaining specialised parts such as PCBs & micros.

- **PCBs are normally IN STOCK and ready for despatch when that month's magazine goes on sale (you don't have to wait for them to be made!).**
- **Even if stock runs out (eg, for high demand), in most cases there will be no longer than a two-week wait.**
- **One low p&p charge: $10 per order, regardless of how many boards or micros you order! (Australia only; overseas clients – email us for a postage quote).**
- **Our PCBs are beautifully made, very high quality fibreglass boards with pre-tinned tracks, silk screen overlays and where applicable, solder masks.**
- **Best of all, those boards with fancy cut-outs or edges are already cut out to the *Silicon Chip* specifications – no messy blade work required!**

HERE'S HOW TO ORDER:

VISA MasterCard PayPal

✔ **Via the INTERNET (24 hours, 7 days)**
Log on to our secure website: siliconchip.com.au, click on "SHOP" and follow the links

✔ **Via EMAIL (24 hours, 7 days)**
email silicon@siliconchip.com.au – clearly tell us what you want and include your contact and credit card details

✔ **Via FAX (24 hours, 7 days)**
(02) 9939 2648 (INT: 612 9939 2648). Clearly tell us what you want and include your contact and credit card details

✔ **Via MAIL (24 hours, 7 days)**
PO Box 139, Collaroy NSW 2097. Clearly tell us what you want and include your contact and credit card details

✔ **Via PHONE (9am-5pm, Mon-Fri)**
Call (02) 9939 3295 (INT 612 9939 3295) – have your order details, including contact and credit card, ready!

YES! You can also order or renew your SILICON CHIP subscription via any of these methods as well!

PRE-PROGRAMMED MICROS

Price for any of these micros is just $15.00 each + $10 p&p per order#

As a service to readers, ***Silicon Chip OnlineShop*** stocks microcontrollers and microprocessors *used in new projects* (from 2012 on) and some selected older projects – pre-programmed and ready to fly! *Some micros from copyrighted and/or contributed projects may not be available.*

PIC12F675-I/P	UHF Remote Switch (Jan09), Ultrasonic Cleaner (Aug10), Ultrasonic Anti-fouling (Sep10), Cricket/Frog (Jun12) Do Not Disturb (May13) IR-to-UHF Converter (Jul13), UHF-to-IR Converter (Jul13)
PIC16F1507-I/P	Wideband Oxygen Sensor (Jun-Jul12)
PIC16F88-E/P	Hi Energy Ignition (Nov/Dec12)
PIC16F88-I/P	Projector Speed (Apr11), Vox (Jun11), Ultrasonic Water Tank Level (Sep11), Quizzical (Oct11) Ultra LD Preamp (Nov11) 10-Channel Remote Control Receiver (Jun13) Revised 10-Channel Remote Control Receiver (Jul13)
PIC16LF88-I/P	Garbage Reminder (Jan13)
PIC16LF88-I/SO	LED Ladybird (Apr13)
PIC16F877A-I/P	6-Digit GPS Clock (May-Jun09), Lab Digital Pot (Jul10) Semtest (Feb-May12)
PIC18F2550-I/SP	Batt Capacity Meter (Jun09), Intelligent Fan Controller (Jul10)
PIC18F45K80	USB Power Monitor (Dec12)
PIC18F4550-I/P	GPS Car Computer (Jan10), GPS Boat Computer (Oct10)
PIC18F14K50	USB MIDIMate (Oct11)
PIC18F27J53-I/SP	USB Data Logger (Dec10-Feb11)
PIC18LF14K22	Digital Spirit Level (Aug11), G-Force Meter (Nov11)
PIC18F1320-I/SO	Intelligent Dimmer (Apr09)
PIC32MX795F512H-80I/PT	Maximite (Mar11), miniMaximite (Nov11), Colour Maximite (Sept/Oct12)
dsPIC33FJ128GP802-I/SP	Digital Audio Signal Generator (Mar-May10), Digital Lighting Controller (Oct-Dec10), SportSync (May11), Digital Audio Delay (Dec11) Level (Sep11) Quizzical (Oct11), Ultra-LD Preamp (Nov11), LED Musicolor (Nov12)
dsPIC33FJ128GP306-I/PT	CLASSIC DAC (Feb-May 13)
ATTiny861	VvA Thermometer/Thermostat (Mar10), Rudder Position Indicator (Jul11)
ATTiny2313	Remote-Controlled Timer (Aug10)
ATMega48	Stereo DAC (Sep-Nov09)

 # P&P prices are within Australia. O'seas? Please email for a quote

When ordering, be sure to nominate BOTH the micro required AND the project for which it must be programmed.

SPECIALISED COMPONENTS, SHORT-FORM KITS, ETC

P&P – $10 Per order#

G-FORCE METER/ACCELEROMETER Short form kit (Aug11/Nov11) **$44.50**
(contains PCB (04108111), programmed PIC micro, MMA8451Q accelerometer chip and 4 Mosfets)

DIGITAL SPIRIT LEVEL Short form kit (Aug11/Nov11) **$44.50**
(contains PCB (04108111), programmed PIC micro, MMA8451Q accelerometer chip and 4 Mosfets)

CLASSIC DAC Semi kit (Feb-May13) **$45.00**
Includes three hard-to-get SMD ICs: CS8416-CZZ, CS4398-CZZ and PLL1708DBQ plus an accurate 27MHz crystal and ten 3mm blue LEDs with diffused lenses

"LUMP IN COAX" MINI MIXER SMD parts kit: (Jun13) **$20.00**
Includes: 2 x 0PA4988AID, 1 x BQ2057CSN, 2 x DMP2215L, 1 x BAT54S, 1 x 0.22Ω shunt

LF-HF UP-CONVERTER SMD parts kit: (Jun13) **$15.00**
Includes: FX0-HCS36R-125 and SA602AD and all SMD passive components

ISL9V5036P3 IGBT (Nov/Dec12) **$10.00**
As used in high energy ignition and Jacob's Ladder (Feb13)

ERA-2SM+ Wideband MMC and ADCH-80+ Wideband Choke
as used in the 2.5GHz Frequency Counter (Dec12/Jan13) **$15.00**

IPP230N06L3 N-Channel logic level Mosfets **$5.00**
As used in a variety of Silicon Chip Projects (Pack of 2)

ZXCT1009 Current Shunt Monitor IC **$5.00**
As used in DCC Reverse Loop Controller/Block Switch (Pack of 2)

TENDA USB/SD AUDIO PLAYBACK MODULE (TD896 *or* 898) (Jan12) **$33.00**

JST CONNECTOR LEAD 3-WAY (Jan12) **$4.50**

JST CONNECTOR LEAD 2-WAY (Jan12) **$3.45**

RADIO & HOBBIES ON DVD-ROM (Needs PC to play!) n/a **$62.00**

LOOKING FOR TECHNICAL BOOKS? YOU'LL FIND THE COMPLETE LISTING OF ALL BOOKS AVAILABLE IN THE SILICON CHIP ONLINE BOOKSTORE ON THE "BOOKS & DVDs" PAGES OF OUR WEBSITE

* ALL ITEMS SUBJECT TO AVAILABILITY. PRICES VALID FOR MONTH OF MAGAZINE ISSUE ONLY. ALL PRICES IN AUSTRALIAN DOLLARS AND INCLUDE GST WHERE APPLICABLE. 07/13

PRINTED CIRCUIT BOARDS

NOTE: These listings are for the PCB only – *not a full kit.* If you want a kit, contact the kit suppliers advertising in this issue.

PRINTED CIRCUIT BOARD TO SUIT PROJECT:	PUBLISHED:	PCB CODE:	Price:
AM RADIO TRANSMITTER	JAN 1993	06112921	$25.00
CHAMP: SINGLE CHIP AUDIO AMPLIFIER	FEB 1994	01102941	$5.00
PRECHAMP: 2-TRANSISTOR PREAMPLIER	JUL 1994	01107941	$5.00
HEAT CONTROLLER	JULY 1998	10307981	$10.00
MINIMITTER FM STEREO TRANSMITTER	APR 2001	06104011	$25.00
MICROMITTER FM STEREO TRANSMITTER	DEC 2002	06112021	$10.00
SMART SLAVE FLASH TRIGGER	JUL 2003	13107031	$10.00
12AX7 VALVE AUDIO PREAMPLIFIER	NOV 2003	01111031	$25.00
POOR MAN'S METAL LOCATOR	MAY 2004	04105041	$10.00
BALANCED MICROPHONE PREAMP	AUG 2004	01108041	$25.00
LITTLE JIM AM TRANSMITTER	JAN 2006	06101062	$25.00
POCKET TENS UNIT	JAN 2006	11101061	$25.00
STUDIO SERIES RC MODULE	APRIL 2006	01104061	$25.00
ULTRASONIC EAVESDROPPER	AUG 2006	01208061	$25.00
RIAA PREAMPLIFIER	AUG 2006	01108061	$25.00
GPS FREQUENCY REFERENCE (A) (IMPROVED)	MAR 2007	04103073	$30.00
GPS FREQUENCY REFERENCE DISPLAY (B)	MAR 2007	04103072	$20.00
KNOCK DETECTOR	JUNE 2007	05106071	$25.00
SPEAKER PROTECTION AND MUTING MODULE	JULY 2007	01207071	$20.00
CDI MODULE SMALL PETROL MOTORS	MAY 2008	05105081	$15.00
LED/LAMP FLASHER	SEP 2008	11009081	$10.00
12V SPEED CONTROLLER/DIMMER (Use Hot Wire Cutter PCB from Dec 2010 [18112101])			
USB-SENSING MAINS POWER SWITCH	JAN 2009	10101091	$45.00
DIGITAL AUDIO MILLIVOLTMETER	MAR 2009	04103091	$35.00
INTELLIGENT REMOTE-CONTROLLED DIMMER	APR 2009	10104091	$10.00
INPUT ATTENUATOR FOR DIG. AUDIO MVOLTMETER	MAY 2009	04205091	$10.00
6-DIGIT GPS CLOCK	MAY 2009	04105091	$35.00
6-DIGIT GPS CLOCK DRIVER	JUNE 2009	07106091	$25.00
UHF ROLLING CODE TX	AUG 2009	15008091	$10.00
UHF ROLLING CODE RECEIVER	AUG 2009	15008092	$45.00
6-DIGIT GPS CLOCK AUTODIM ADD-ON	SEPT 2009	04208091	$10.00
STEREO DAC BALANCED OUTPUT BOARD	JAN 2010	01101101	$25.00
DIGITAL INSULATION METER	JUN 2010	04106101	$25.00
ELECTROLYTIC CAPACITOR REFORMER	AUG 2010	04108101	$55.00
ULTRASONIC ANTI-FOULING FOR BOATS	SEP 2010	04109101	$25.00
HEARING LOOP RECEIVER	SEP 2010	01209101	$25.00
S/PDIF/COAX TO TOSLINK CONVERTER	OCT 2010	01210101	$10.00
TOSLINK TO S/PDIF/COAX CONVERTER	OCT 2010	01210102	$10.00
DIGITAL LIGHTING CONTROLLER SLAVE UNIT	OCT 2010	16110102	$45.00
HEARING LOOP TESTER/LEVEL METER	NOV 2010	01111101	$25.00
UNIVERSAL USB DATA LOGGER	DEC 2010	04112101	$25.00
HOT WIRE CUTTER CONTROLLER	DEC 2010	18112101	$10.00
433MHZ SNIFFER	JAN 2011	06101111	$10.00
CRANIAL ELECTRICAL STIMULATION	JAN 2011	99101111	$30.00
HEARING LOOP SIGNAL CONDITIONER	JAN 2011	01101111	$30.00
LED DAZZLER	FEB 2011	16102111	$25.00
12/24V 3-STAGE MPPT SOLAR CHARGER	FEB 2011	14102111	$15.00
SIMPLE CHEAP 433MHZ LOCATOR	FEB 2011	06102111	$5.00
THE MAXIMITE	MAR 2011	06103111	$25.00
UNIVERSAL VOLTAGE REGULATOR	MAR 2011	18103111	$15.00
12V 20-120W SOLAR PANEL SIMULATOR	MAR 2011	04103111	$25.00
MICROPHONE NECK LOOP COUPLER	MAR 2011	01209101	$25.00
PORTABLE STEREO HEADPHONE AMP	APRIL 2011	01104111	$25.00
CHEAP 100V SPEAKER/LINE CHECKER	APRIL 2011	04104111	$10.00
PROJECTOR SPEED CONTROLLER	APRIL 2011	13104111	$10.00
SPORTSYNC AUDIO DELAY	MAY 2011	01105111	$30.00
100W DC-DC CONVERTER	MAY 2011	11105111	$25.00
PHONE LINE POLARITY CHECKER	MAY 2011	12105111	$10.00
20A 12/24V DC MOTOR SPEED CONTROLLER MK2	JUNE 2011	11106111	$25.00
USB STEREO RECORD/PLAYBACK	JUNE 2011	07106111	$25.00
VERSATIMER/SWITCH	JUNE 2011	19106111	$25.00
USB BREAKOUT BOX	JUNE 2011	04106111	$10.00
ULTRA-LD MK3 200W AMP MODULE	JULY 2011	01107111	$25.00
PORTABLE LIGHTNING DETECTOR	JULY 2011	04107111	$25.00
RUDDER INDICATOR FOR POWER BOATS (4 PCBs)	JULY 2011	20107111-4	$80 per set
VOX	JULY 2011	01207111	$25.00
ELECTRONIC STETHOSCOPE	AUG 2011	01108111	$25.00
DIGITAL SPIRIT LEVEL/INCLINOMETER	AUG 2011	04108111	$15.00
ULTRASONIC WATER TANK METER	SEP 2011	04109111	$25.00
ULTRA-LD MK2 AMPLIFIER UPGRADE	SEP 2011	01209111	$5.00
ULTRA-LD MK3 AMPLIFIER POWER SUPPLY	SEP 2011	01109111	$25.00
HIFI STEREO HEADPHONE AMPLIFIER	SEP 2011	01309111	$30.00
GPS FREQUENCY REFERENCE (IMPROVED)	SEP 2011	04103073	$30.00
DIGITAL LIGHTING CONTROLLER LED SLAVE	OCT 2011	16110111	$30.00
USB MIDIMATE	OCT 2011	23110111	$30.00

PRINTED CIRCUIT BOARD TO SUIT PROJECT:	PUBLISHED:	PCB CODE:	Price:
QUIZZICAL QUIZ GAME	OCT 2011	08110111	$30.00
ULTRA-LD MK3 PREAMP & REMOTE VOL CONTROL	NOV 2011	01111111	$30.00
ULTRA-LD MK3 INPUT SWITCHING MODULE	NOV 2011	01111112	$25.00
ULTRA-LD MK3 SWITCH MODULE	NOV 2011	01111113	$10.00
ZENER DIODE TESTER	NOV 2011	04111111	$20.00
MINIMAXIMITE	NOV 2011	07111111	$10.00
ADJUSTABLE REGULATED POWER SUPPLY	DEC 2011	18112111	$5.00
DIGITAL AUDIO DELAY	DEC 2011	01212111	$30.00
DIGITAL AUDIO DELAY Front & Rear Panels	DEC 2011	01212112P2/3	$20 per set
AM RADIO	JAN 2012	06101121	$10.00
STEREO AUDIO COMPRESSOR	JAN 2012	01201121	$30.00
STEREO AUDIO COMPRESSOR FRONT & REAR PANELS	JAN 2012	01201121P1/2	$20.00
3-INPUT AUDIO SELECTOR (SET OF 2 BOARDS)	JAN 2012	01101121/2	$30 per set
CRYSTAL DAC	FEB 2012	01102121	$20.00
SWITCHING REGULATOR	FEB 2012	18102121	$5.00
SEMTEST LOWER BOARD	MAR 2012	04103121	$40.00
SEMTEST UPPER BOARD	MAR 2012	04103122	$40.00
SEMTEST FRONT PANEL	MAR 2012	04103123	$75.00
INTERPLANETARY VOICE	MAR 2012	08102121	$10.00
12/24V 3-STAGE MPPT SOLAR CHARGER REV.A	MAR 2012	14102112	$20.00
SOFT START SUPPRESSOR	APR 2012	10104121	$10.00
RESISTANCE DECADE BOX	APR 2012	04104121	$20.00
RESISTANCE DECADE BOX PANEL/LID	APR 2012	04104122	$20.00
1.5kW INDUCTION MOTOR SPEED CONT. (New V2 PCB)	APR (DEC) 2012	10105122	$35.00
HIGH TEMPERATURE THERMOMETER MAIN PCB	MAY 2012	21105121	$30.00
HIGH TEMPERATURE THERMOMETER Front & Rear Panels	MAY 2012	21105122/3	$20 per set
MIX-IT! 4 CHANNEL MIXER	JUNE 2012	01106121	$20.00
PIC/AVR PROGRAMMING ADAPTOR BOARD	JUNE 2012	24105121	$30.00
CRAZY CRICKET/FREAKY FROG	JUNE 2012	08109121	$10.00
CAPACITANCE DECADE BOX	JULY 2012	04106121	$20.00
CAPACITANCE DECADE BOX PANEL/LID	JULY 2012	04106122	$20.00
WIDEBAND OXYGEN CONTROLLER MK2	JULY 2012	05106121	$20.00
WIDEBAND OXYGEN CONTROLLER MK2 DISPLAY BOARD	JULY 2012	05106122	$10.00
SOFT STARTER FOR POWER TOOLS	JULY 2012	10107121	$10.00
DRIVEWAY SENTRY MK2	AUG 2012	03107121	$20.00
MAINS TIMER	AUG 2012	10108121	$10.00
CURRENT ADAPTOR FOR SCOPES AND DMMS	AUG 2012	04108121	$20.00
USB VIRTUAL INSTRUMENT INTERFACE	SEPT 2012	24109121	$30.00
USB VIRTUAL INSTRUMENT INT. FRONT PANEL	SEPT 2012	24109122	$30.00
BARKING DOG BLASTER	SEPT 2012	25108121	$20.00
COLOUR MAXIMITE	SEPT 2012	07109121	$20.00
SOUND EFFECTS GENERATOR	SEPT 2012	09109121	$10.00
NICK-OFF PROXIMITY ALARM	OCT 2012	03110121	$5.00
DCC REVERSE LOOP CONTROLLER	OCT 2012	09110121	$10.00
LED MUSICOLOUR	NOV 2012	16110121	$25.00
LED MUSICOLOUR Front & Rear Panels	NOV 2012	16110122	$20 per set
CLASSIC-D CLASS D AMPLIFIER MODULE	NOV 2012	01108121	$30.00
CLASSIC-D 2 CHANNEL SPEAKER PROTECTOR	NOV 2012	01108122	$10.00
HIGH ENERGY ELECTRONIC IGNITION SYSTEM	DEC 2012	05110121	$10.00
USB POWER MONITOR	DEC 2012	04109121	$10.00
1.5kW INDUCTION MOTOR SPEED CONTROLLER (NEW V2 PCB)	DEC 2012	10105122	$35.00
THE CHAMPION PREAMP and 7W AUDIO AMP (one PCB)	JAN 2013	01109121/2	$10.00
GARBAGE/RECYCLING BIN REMINDER	JAN 2013	19111121	$10.00
2.5GHz DIGITAL FREQUENCY METER – MAIN BOARD	JAN 2013	04111121	$35.00
2.5GHz DIGITAL FREQUENCY METER – DISPLAY BOARD	JAN 2013	04111122	$15.00
2.5GHz DIGITAL FREQUENCY METER – FRONT PANEL	JAN 2013	04111123	$45.00
SEISMOGRAPH MK2	FEB 2013	21102131	$20.00
MOBILE PHONE RING EXTENDER	FEB 2013	12110121	$10.00
GPS 1PPS TIMEBASE	FEB 2013	04103131	$10.00
LED TORCH DRIVER	MAR 2013	16102131	$5.00
CLASSIC DAC MAIN PCB	APR 2013	01102131	$40.00
CLASSIC DAC FRONT & REAR PANEL PCBs	APR 2013	01102132/3	$30.00
GPS USB TIMEBASE	APR 2013	04104131	$15.00
LED LADYBIRD	APR 2013	08103131	$5.00
CLASSIC-D 12V to ±35V DC/DC CONVERTER	MAY 2013	11104131	$15.00
DO NOT DISTURB	MAY 2013	12104131	$10.00
LF/HF UP-CONVERTER	JUN 2013	07106131	$10.00
10-CHANNEL REMOTE CONTROL RECEIVER	JUN 2013	15106131	$15.00
IR-TO-455MHZ UHF TRANSCEIVER	JUN 2013	15106132	$7.50
"LUMP IN COAX" PORTABLE MIXER	JUN 2013	01106131	$15.00
L'IL PULSER MKII TRAIN CONTROLLER	JULY 2013	19106131	$15.00
L'IL PULSER MKII FRONT & REAR PANELS	JULY 2013	09107132/3	$20.00/set
REVISED 10 CHANNEL REMOTE CONTROL RECEIVER	JULY 2013	15106133	$15.00
INFRARED TO UHF CONVERTER	JULY 2013	15107131	$5.00
UHF TO INFRARED CONVERTER	JULY 20 13	15107132	$10.00

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Send your email to silicon@siliconchip.com.au

6-Digit GPS Clock has readout flicker

I am currently building Jim Rowe's 6-Digit GPS Clock from the May-June 2009 issues for my senior project at my college. I have it completely breadboarded and fully functional but with a constant visible flicker from the 7-segment displays.

I would like to know if that flicker was present during the initial design and if there are any possible solutions to get rid of it. (M. A., New Brunswick, Canada).

● The display flicker may be due to the particular 7-segment displays used in your breadboard prototype. The frequency at which the displays are multiplexed is fixed by the firmware inside the PIC microcontroller, at a rate which produced very little flicker with the displays we used. If the displays you are using have a different optical efficiency, this could make the flicker more visible.

All we can suggest is that you experiment with the values of the display segment current-setting resistors connected between the collectors of transistors Q8-Q14 and the display segment lines. These currently have a value of 56Ω but you could try replacing them with lower values (say 47Ω) to see if the visible flicker is reduced.

You should also check that the supply voltage is correct, as excessive ripple could cause flicker.

Running a lathe with a 180V DC motor

I am currently building a small lathe for hobby use and have managed to find a 180V DC motor with a 1.5HP rating from a treadmill which would be ideal as a drive motor. The original controller is not working and appears to use a microcontroller in the console and a PWM driver in the motor compartment; even if it were working it would be too big to mount on the lathe.

The controller had an optical sensor for speed sensing and although nice to have, it is not really necessary. I have hunted around on the internet and found most of these PWM drivers need a microcontroller board to control them or they cost big dollars. I was wondering if some modification to the High-Current Speed Controller for 12-24V DC systems would be possible?

The original controller used an IRFP460A N-channel enhancement mode Mosfet as a switching transistor and a F30V60DN fast recovery diode to clamp the transient spike voltages.

I already have the 12-24V DC Controller (Silicon Chip, June 2011) that I constructed for another project. The driver section from the old controller still works (the microcontroller is dead so the PWM board will not activate) and I have managed to set it up so that the 12-24V DC controller will switch the IRFP460A transistor on and off as required but I have only tested it using 12V DC which works fine.

The big question is how to get it to work with two different power supplies, one at 20V DC and the other at 230V DC. As I see it, the grounds of these two supplies need to be connected together so that Q3 (BC327) can conduct to switch the drive Mosfet as the 12-24V circuit is isolated by a transformer from the 230V DC circuit.

Any thoughts on this would be appreciated. I read somewhere that rectifying 230VAC gives something

Sick Battery Makes For A Sick Ignition System

I am writing with regard to the new High-Energy Ignition System that I built, now fitted with a nice new Commodore coil which works really well. I should say worked really well until the battery on the wood chipper it is fitted to got a bit low and the machine stopped working.

I must admit that I had fun searching for possible faults, changing spark plugs, cleaning points, running new cables, changing where the new module was mounted, etc.

It got to the stage where the machine would start and run for about 30 seconds, then simply die with no spark. Wait for five minutes and it would start and run for another 30 seconds. This happened quite often and although I could read the voltage on the module while the machine was idle, by the time I got the thing started and got the meter on the test point, the motor would shut down again.

Finally, I connected the battery charger to top up the battery (the built-in charger in the machine is pretty sick and virtually useless) and then thought I would try something else. I don't remember what it was but anyway I started the motor and it kept running! The battery voltage was around the 12V mark when I started all this so is there some mechanism within the module that would shut down the works if the battery gets low? (D. H., via email).

● There is no protection mechanism to shut down operation if the battery voltage gets too low. We have done that deliberately, otherwise you would not be able to start the motor if the battery was a bit marginal.

However, the micro does monitor the battery voltage to adjust the dwell (the time the current flows through the coil before each spark). This means that if the battery is a bit sick and the voltage is reducing, the micro will increase the dwell to keep the spark energy constant. This actually means that as the battery voltage reduces, the current draw will increase. A sick battery will be made sicker.

around 330V DC. There is the other side of the coin also in that I could use a 24-36V DC motor from a scooter but then there is the issue of supplying it with a current of up to 80A without using batteries which leaves one in the dark and messy world of switchmode power supplies.

Most of the small hobby lathes and milling machines use 180V DC motors usually rated at around 500W and a controller kit for these would be a dream come true as the motors are fairly cheap and have a small footprint but they sting you for the controller. (I. B., via email).

● Interconnecting the two controllers could be as easy as just having a common ground between the 12V controller negative supply and the negative supply of the original PWM controller with the dead microcontroller. However, there may be other connection issues depending on how the original PWM board works and what signal is required to drive it. We do not know whether the 230V section is fully isolated from the input signal (dead microcontroller section) or whether it is floating.

230/240VAC mains when rectified will give 230/240V RMS pulsating DC. If it is filtered with a capacitor to provide smooth DC, then the capacitor will charge to the peaks of the half sinewave shaped DC waveform. That peak is some 1.414 ($\sqrt{2}$) times the RMS value or 325/339V DC.

Modifying the current adaptor for scopes

I am currently building the Isolated Current Adaptor For Scopes (SILICON CHIP, August 2012). I want to use the ACS712-30A version and you state that its output is 66mV/amp. I wanted to get around this awkward number by putting a resistive divider of 50/66 to make its output easily read on the 50mV scale. This could be done with a resistor ratio of 24kΩ:75kΩ.

I have worked out a simple modification: replace the link from IC3 pin 7 with a 24kΩ resistor and then install a 75kΩ resistor between pins 3 & 4 of IC4a. What is your opinion on this? (S. S., via email).

● That should work but the lower resistor (75kΩ) should go between pins 3 & 5 of IC4. That's because the output of IC3 is at 2.5V when no current flows and pin 5 of IC4b is the "virtual earth", which is at a similar voltage.

The ACS712 can supply up to 3mA from its output pin 7 so you could therefore possibly use lower value resistors (2.4kΩ & 7.5kΩ) but the values you have selected should be OK.

Wiring Confusion In 12GHz Frequency Counter

I am in the process of building the 12GHz Frequency Counter and made a mistake with the orientation of the ends of the ribbon cable joiner. In re-doing this, I noticed a problem in the article.

The layout of the display PCB shows pins 1 & 2 at the centre-line end of the connector (page 69, January 2013). The layout of the main PCB (page 71, January 2013) also has pins 1 & 2 at the centreline end. However, in the main board view, the header side guide block is shown on the 1-19 side whereas in the display view, the side block is shown on the 2-20 side.

This issue is compounded by the two "open box" views on page 34 of the December 2012 issue and on page 73 (January issue) where the joining cable has the red stripe (pin 1) on opposite sides. I am inclined to think what is shown on page 73 is wrongly joined. As the orientation of the joiner plugs could mean a malfunction if not set correctly, could you please check and inform me? (L. W., via email).

● You are probably being misled by the way the ribbon cable is shown in the photos (page 73 and 75 of the January issue) with its 'red stripe' side towards the power switch and regulator, while it's shown by implication on the other side of the ribbon in the diagram of Fig.10. Our apologies for this apparent contradiction but the fact is that the ribbon cable will in fact work either way around, as long as the connectors are fitted to it exactly as shown in Fig.11 (page 75 of the January 2013 issue).

Because the cable and its connectors are symmetrical, the correct connections will be made regardless of which end is connected to CON6 on the display board and CON5 on the main board. They just have to be plugged into each connector with the indexing "block" of the plug mating with the gap in the PCB socket.

Ignition mods for LPG/petrol vehicle

Can I ask if the code for the recent High-Energy Ignition System(SILICON CHIP, November & December 2012) could be modified for use with an older LPG/petrol fuel system? The modification would need to advance the timing by 15° when LPG is selected.

It would also require another input but I noticed pins 2, 3, 7 & 17 are not used. A low-pass filter similar to the trigger input would also be required, although the filter could be a lot stronger as the change-over period tends to be days not milliseconds. (D. E., via email).

● That particular ignition system requires too many modifications. But you can use the Programmable Ignition from March, April & May 2007. It allows for advance and a dual ignition timing map selectable with a switch.

The standard high energy ignition systems are not suited for advancing the timing since the advance calculation depends on the number of cylinders and stroke that the engine has and that would need to be entered into the ignition system. The keyboard for the Programmable Ignition allows for the required parameters to be entered.

It may also be necessary to vary the 15° advance with RPM and load to get the best performance under all conditions. The Programmable Ignition allows for mapping advance against RPM and load and not just a fixed advance.

Jaycar have the kits for the Programmable Ignition, Coil Driver and Hand Controller (KC5442, KC5443 and KC5386).

How to store semiconductors safely

I have a question regarding storage of semiconductors. I have some plastic storage drawers which are not classed as ESD-safe, just regular plastic drawers. What I'd like to know, is it OK to to store semiconductors in the plastic drawers, just in the plastic tubes or tape that they come in and not the anti-static bags, as they take up too

Digital Input DAC Preamp Next?

I was very interested to read your latest articles for the CLASSiC DAC project in the February-May 2013 issues. This is a large improvement on the earlier one. Looking at the specifications provided in the article, the THD+N was of the order 0.01% whereas the same for a preamp designed by yourselves at a much earlier time was of the order 0.001% (sorry, all I recall was that there was approximately a factor of 10 difference).

That said, I have an Oppo DVD player which allegedly has a 32-bit processor (the blurb suggests two of them) and has all the outputs you can poke a stick at, connected via analog RCA sockets to my preamplifier (your earlier design; kit from Altronics). I would of course prefer to use digital outputs from the Oppo to your DAC but it would appear that this would result in a degradation of the THD+N if inserted.

The question then comes to my mind: are we at some time in the future heading for a high-quality preamp with TOS/Philips digital inputs which would have the specs of your earlier preamp designs or is this limited by the DAC and associated chip sets? (C. G., via email).

● There isn't really that much difference in performance between the CLASSiC DAC and the Ultra-LD Mk.3 (or similar) preamplifier, especially when you consider how they are normally used.

THD+N for the CLASSiC DAC is around 0.001% but a lot of that is noise. THD+N for the preamp is probably below 0.0004% but that's at a fairly loud volume setting. Depending on the amplifier, speakers, etc, you may be running it with much less signal in which case the noise becomes more significant and its THD+N probably increases to a similar level to the DAC.

In either case, the noise is normally low enough that it's inaudible unless perhaps you press your ear up against the speaker grille.

Distortion does rise a bit more for the DAC than the preamp at high frequencies but it's still low enough to be considered essentially inaudible up to fairly high signal frequencies (eg, 10kHz).

Keep in mind that a lot of this is moot if you are using CD source material since the aliasing noise from 16-bit digital data is greater than the noise and distortion contributed by the DAC itself. In other words, there is more distortion inherent in the digital storage medium than there is in the playback equipment. To get the performance figures we are quoting, you generally need to use 24-bit/96kHz source material or better.

It is possible to reduce distortion at high frequencies from CD material using fancy digital processing, which we've seen done in Marantz CD players. This may not make any audible difference but if you want a CD player with distortion <0.001% at 10kHz then Marantz is a good option. In practice though, we think our DAC will sound pretty much the same.

We are not familiar with Oppo DVD players so we cannot comment on how the performance will compare or whether you would hear a difference or not.

We are considering doing a preamp as you suggest, based on the CLASSiC DAC. No promises as to when that might be, though.

much room inside the bags? Or is there something else that can be done, as keeping everything in bags takes up a lot of room and doesn't allow similar items to be grouped in the kind of drawers that I have?

Also, will putting that anti-static foam on the bottom work in protecting components which are kept outside their anti-static bags? (B. W., via email).

● The tube/tape should be an anti-static type and will protect the parts inside adequately as long as you aren't regularly zapping them with big sparks (ie, ground yourself before touching them). Most suppliers seem to go overboard with layers of anti-static protection because they don't want their customers returning items, claiming they were damaged by static in transit and so on.

For through-hole parts, our preferred method is to cut up small squares of anti-static foam (eg, Jaycar ZV9998) and stick the component leads into that. It's a little expensive but it can be re-used and goes quite a long way, especially if you use both sides. It's also relatively compact, especially when used with DIP ICs. As long as all the leads are firmly in the foam, it should protect them well.

3-channel remote control system wanted

Could you please advise if you have published an RF remote control project that satisfies the following. I am wanting to make my rooftop mounted evaporative cooler into a remote-controlled device. I will need an RF remote control transmitter and receiver with at least three channels.

Channel 1 would be for on /off and a toggled channel is OK. Channel 2 is for control of the water pump, dump valve & inlet water solenoid and a toggle is also OK. Channel 3 would be for the fan motor variable speed and capable of driving a motorised pot in forward and reverse to replace the pot in the original manual speed controller, which is a simple Triac-based device.

I need an RF remote as the control box where all the existing wiring is in a walk-in wardrobe and I want to control it from anywhere in the house. High security is not a major factor for this project. (P. C., via email).

● We published a 3-Channel Rolling Code Remote Control in the August and September 2009 issues of SILICON CHIP (back issues available at www.siliconchip.com.au). Its outputs are mains-rated and can be momentary or toggle. Altronics sell the kits (K1957 transmitter and K1958 receiver, www.altronics.com.au).

Help with fuel pump control for boat

A few years ago, I bought your Frequency Switch project (Jaycar Cat. KC5378) for automatic switching of my motorbike's headlights and it works

Feedback Query On 4-Channel Mixer

I have a technical question about the Mix-It, 4-Channel Mixer project by Nicholas Vinen (SILICON CHIP, June 2012). In each of the preamps it is possible to alter the gain by changing the value of R1-R4 in line with the values in the table provided. What I don't understand is, why is it necessary to change the value of the 220pF feedback capacitor if R1-R4 is changed from 220Ω?

In the article, it says that C1-C4 need to be changed when changing R1-R4 in order to keep the frequency response constant but I am under the impression that the upper cut-off (-3dB point) frequency is only dependent on the 1.8kΩ feedback resistor and the feedback capacitor, not on R1-R4, ie:

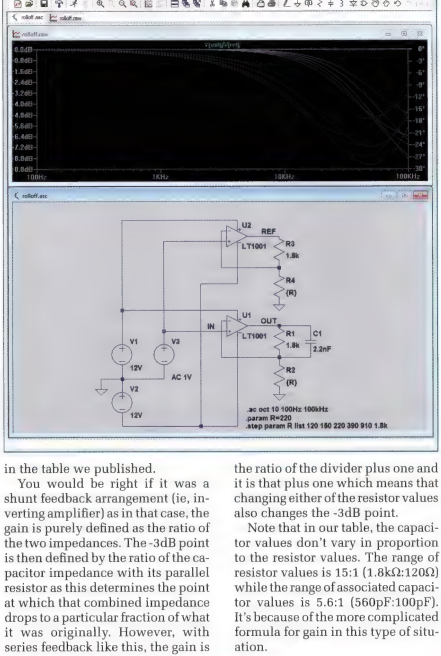
$F_{cutoff} = 1 \div (2\pi \times 1.8k\Omega \times 220pF)$

Therefore, I believe that by keeping the 1.8kΩ and 220pF feedback components values constant, the upper cut-off frequency remains constant even if the gain is changed by altering R1-R4. I don't see any need to alter the value of C1-C4.

Am I wrong in believing this? Maybe there is some practical reason for changing the value of C1-C4, when changing the value of R1-R4, that I have missed.

I would very much appreciate it if you could spare the time to answer my query and put my mind at rest. (C. H., via email).

● Changing either resistor value in this type of circuit affects its frequency response – see the accompanying SPICE simulation. Ignore the dotted lines; the solid lines show the roll-off due to the capacitor with everything staying the same except the bottom resistor in the divider having its value stepped over the range shown in the table we published.



You would be right if it was a shunt feedback arrangement (ie, inverting amplifier) as in that case, the gain is purely defined as the ratio of the two impedances. The -3dB point is then defined by the ratio of the capacitor impedance with its parallel resistor as this determines the point at which that combined impedance drops to a particular fraction of what it was originally. However, with series feedback like this, the gain is the ratio of the divider plus one and it is that plus one which means that changing either of the resistor values also changes the -3dB point.

Note that in our table, the capacitor values don't vary in proportion to the resistor values. The range of resistor values is 15:1 (1.8kΩ:120Ω) while the range of associated capacitor values is 5.6:1 (560pF:100pF). It's because of the more complicated formula for gain in this type of situation.

perfectly. Now we have a new kind of problem.

We want to install a Facet Dura-Lift Fuel Pump on our speedboat for refilling the boat's petrol tank at sea from additional canisters. To prevent overfilling the boat tank, we need a special relay to switch off voltage to the pump. It can be operated by fuel-level sensor resistance.

So do you have some kind of switch like the Frequency Switch but operated by sensor resistance? The relay can supply the voltage. The refilling pump can work only if the sensor resistance is between 240Ω and 50Ω. The power requirements are 12V @ 1.5A. (J. V., via email).

● The Voltage Switch (Jaycar Cat. KC5377) from our book "Performance Electronics For Cars" could be used. You would need to convert the sensor's resistance to a voltage which can be done by connecting a fixed resistor in series with it to form a voltage divider and then connecting this across the 8V supply. A 100Ω 5W rresistor would be suitable.

Parts for solar tracker

I'm looking at making the Solar Tracker depicted on page 58 of the January 2012 issue of SILICON CHIP. However I cannot locate SC1 & SC2 mini

Pulse Generator For Ignition System Demonstration

I am an automotive teacher from Wyong TAFE. I have found some old PCBs that I had forgotten about. They are for a pulse generator using a 555 timer circuit that I used to have my students make as a project for ignition testing. I would like to have some of my current students also use them but I have lost the circuit drawing showing the component layout and the list of components required.

I believe that the original circuit was covered in an article in SILICON CHIP magazine in the 1990s. An earlier circuit also existed but this is a slightly improved circuit as is uses a transistor on the output for testing Hall sensors. Would you still have the circuit details or know where I might find it? If you do have the details could I have a copy? (S. A., Wyong, NSW).

- We have not been able to determine whether this PCB was a magazine design or not. However, if you want a 555-based circuit which will drive an ignition coil, you could have a look at our Jacob's Ladder project from the June 2007 issue. You can access the article at **www.siliconchip.com.au/Issue/2007/April/Build+A+Jacob%E2%80%99s+Ladder** This project is available from Jaycar as a kit – Cat. KC-5445.

Alternatively, you could look at the more up-to-date PIC-based ignition system which can be set up as a self-contained ignition coil tester or as a Jacob's Ladder. This can be accessed at **www.siliconchip.com.au/Issue/2013/February**

We also stock the PCB, programmed micro and the IGBT for this project. See **www.siliconchip.com.au/Shop/**

solar panels or Mosfets FQD17P06 & FQD20NO6. Could I substitute BD139s & BD140s for the Mosfets? Any ideas? (R. C., via email).

- Virtually any general purpose N-channel and P-channel Mosfet can be used in this circuit. You cannot use BD139/140s. They are bipolar transistors, not Mosfets.

For the solar cells, you could try ebay. For example, you could buy a cheap USB solar charger and pull the cells out of that.

Power supply needs higher input voltage

I have just built the PIC Programmer project from your May 2008 issue. I've hooked up the project to run from a 15V DC regulated plugpack.

Checking the LM317's output gave a reading of 12.2V. Just to prove that I was connecting the probes at the right place I measured the output of the 7805 voltage regulator from the same earth point and got a reading of exactly 5V. The reading from the LM317 was stable, not fluctuating.

Now what can I do with this? Does this low reading mean I need a 16V plugpack which was listed in the specifications for the project? Or can I do what they suggest and alter the value of the adjustment resistor? Could you tell me approximately what value it would be?

I am having difficulty getting a 16V plugpack and that is why I am using a 15V plugpack. Do you know where to get one? (R. M., via email).

- The LM317 in that circuit needs more than 15V input to regulate to 13.6V. You could try shorting out D1 but you really need more input volts.

Electric fence controller is reliable

Your Electric Fence Controller from July 1995 interests me. How durable is that design considering you have a 555 timer in close proximity to spiky voltages from the ignition coil primary? Are you sure the 7555 doesn't say a quick "goodbye" and is then "silent" forever more! (W. S., via email).

- That electric fence design is very reliable. The 7555 is protected from transients due to the isolation provided by the series diode and the 47Ω series resistor and the 470µF decoupling capacitor for its supply rail. Proximity to the ignition coil does not affect it as the high-tension voltage is at the far end of the coil, away from the 7555.

If the spark developed by the ignition coil were allowed to conduct through the 7555, then the IC would be damaged but the coil is not orientated to allow that sort of discharge into the circuitry.

The same circuit was used in our Jacob's Ladder project (September 1995), where the coil output was drastically increased to provide a spectacular climbing spark between two

continued on page 104

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine.

Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Competition & Consumer Act 2010 or as subsequently amended and to any governmental regulations which are applicable.

MARKET CENTRE

Cash in your surplus gear. Advertise it here in SILICON CHIP

ENGINEERING SERVICES

NSW/ACT - Electronics IT Specialist - 25 years experience – aerospace – IPC J-STD-001ES – SMD/SMT – electronics & PCB design – embedded systems – hardware & software development – installations – repairs - contact ELCOMTEL – mob: 0468 3527 6415 – **www.elcomtel.com.au** – **info@elcomtel.com.au**

FOR SALE

LEDs! Nichia, Cree and other brand name LEDs at excellent prices. LED drivers, including ultra-reliable linear driver options. Many other interesting and hard-to-find electronic items! **www.ledsales.com.au**

questronix.com.au – audiovisual experts solve home, corporate security and devotional installation & editing woes. QuestAV CYP, Kramer TVone (02) 4343 1970 or **sales@questronix.com.au**

SOLAR PANELS LOW COST: full range 5W to 250W, eg: 40W/12V Poly $69, 130W/12V $169, 190W/24V $165, 200W/12V $225, 250W/24V $225, 230W Poly $190.
AGM Batteries: 7AH $19.50, 9AH $24.50, 20AH $52.50, 55AH $129, 105AH $199, 220AH $399.
(03) 94705851 or (03) 9478 0080
chris@lowenergydevelopments.com.au
www.lowenergydevelopments.com.au
544 High St, Preston 3072, Melbourne.

PCBs & Micros: Silicon Chip Publications can supply PCBs and programmed micros for all recent (and some not so recent) projects described in the magazine – see the PartShop advert in this issue. Order online or phone (02) 9939 3295.

PCBs MADE, ONE OR MANY. Any format, hobbyists welcome. Sesame Electronics Phone (02) 8068 2713.
sesame@sesame.com.au
www.sesame.com.au

KIT ASSEMBLY & REPAIR

KEITH RIPPON KIT ASSEMBLY & REPAIR:
* Australia & New Zealand;
* Small production runs.
Phone Keith 0409 662 794.
keith.rippon@gmail.com

VINTAGE RADIO REPAIRS: electrical mechanical fitter with 36 years experience and extensive knowledge of valve and transistor radios. Professional and reliable repairs. All workmanship guaranteed. $10 inspection fee plus charges for parts and labour as required. Labour fees $35 p/h. Pensioner discounts available on application. Contact Alan on 0425 122 415 or email **bigal007@internode.on.net**

WANTED

CIRCUIT & DESIGN IDEAS: SILICON CHIP pays up to $60 for Circut Notebook items or you could win a $150 gift voucher from Hare & Forbes. See the Circuit Notebook pages for details.

WANTED: EARLY HIFIs, AMPLIFIERS, Speakers, Turntables, Valves, Books, Quad, Leak, Pye, Lowther, Ortofon, SME, Western Electric, Altec, Marantz, McIntosh, Tannoy, Goodmans, Wharfedale, radio and wireless. Collector/Hobbyist will pay cash. (07) 5471 1062. **johnmurt@highprofile.com.au**

WANTED: Palec M-32 multimeter, any condition as long as meter scale is in good shape. **james.goding@monash.edu**

ELNEC IC PROGRAMMERS
High quality
Realistic prices
Free software updates
Large range of adaptors
Windows 95/98/Me/NT/2k/XP

CLEVERSCOPE USB OSCILLOSCOPES
2 x 100MSa/s 10bit inputs + trigger
100MHz bandwidth
8 x digital inputs
4M samples/input
Sig-gen + spectrum analyser
Windows 98/Me/NT/2k/XP

IMAGECRAFT C COMPILERS
ANSI C compilers, Windows IDE
AVR, TMS430, ARM7/ARM9
68HC08, 68HC11, 68HC12

GRANTRONICS PTY LTD
www.grantronics.com.au

Printed Circuit Board Manufacture
48-Hour service • High quality • Low prices
1 offs to any quantity
Artwork design if required
Call for obligation free quote...
INSTANT PCBs, POBox 448, Avalon 2107
Ph (02)9974 1189 Fax (02)9974 5491

Issues Getting Dog-Eared?
Keep your copies of SILICON CHIP safe with these handy binders
Order from **www.siliconchip.com.au/Shop/4** or call (02) 9939 3295 and quote your credit card number.*See website for overseas prices.

ADVERTISING IN MARKET CENTRE

Classified Ad Rates: $29.50 for up to 20 words plus 85 cents for each additional word. Display ads in Market Centre start at $110.00. All prices include GST.

Closing date: 5 weeks prior to month of sale. To book, email the text to **silicon@siliconchip.com.au** and include your name, address & credit card details, or phone Glyn (02) 9939 3295 or 0431 792 293.

RFMA RF Modules Australia
Low Power Wireless Connectivity Specialists

SMX1-151-5-100mW
TX POWER NOW 100mW
128 Channel. Narrowband
150.825~152.450MHz
Data rate: 5kbps
Internal 1200baud Modem
Also: SMX1-173-5-100mW (NZ)

Applications:
Rural
Utilities
Industrial
Commercial
Government
Meter Reading

RADIOMETRIX: Low Power, License Exempt

RF Modules Australia. P.O. Box 1957 Launceston, TAS., 7250.
Ph: 03-6331-6789. Email: sales@rfmodules.com.au. Web: rfmodules.com.au

Ask SILICON CHIP

. . . continued from page 102

conductors. If the circuit were prone to failure, that would be a good test.

For extra protection in this circuit for the Jacob's ladder we added a 16V zener diode across the 7555's supply. That zener was only included due to the much higher coil discharge.

VHF antenna for Band 3 reception

With the imminent switch-over to digital TV in our major capital cities this year, some readers may not be aware that after this the Government's digital dividend will result in re-stacking the television channels to band 3 (VHF), at least for the major capital cities.

In May 1986, Leo Simpson and Bob Flynn presented an article in the old EA magazine for a high-gain Yagi antenna for Channel 28, something that I built and had great success with in capturing transmissions from outlying country areas from Melbourne. Currently, this antenna is used to receive Melbourne digital TV as well as DAB+ radio and it still works well.

I was wondering if SILICON CHIP could do a similar project especially designed to operate in band 3 for channels 6-12. From my perspective, I can't wait to eliminate the directors no longer required to receive the old analog channels such as ABC 2; the pigeons would need to find a new home! (A. P., North Sunshine, Vic).

● We covered this topic last month. The problem with describing DIY antennas is that the cost of aluminium rods etc is so expensive that by the time you buy all the material and hardware required, it is cheaper to purchase the finished antenna. As a bonus, it will be fully anodised and should last for many years.

Having said that, there is probably nothing to stop you from modifying an existing wide band Yagi by removing the long directors and reflector needed for channels below Channel 6. The folded dipole would need to be reduced in dimension as well. A photo in last month's article showed how an existing antenna would need to be modified. However, unless the antenna was in quite good condition initially, trying to modify and refurbish it could be a lot of time and effort.

DOWNLOAD OUR CATALOG AT
www.iinet.net.au/~worcom
WORLDWIDE ELECTRONIC COMPONENTS
PO Box 631, Hillarys, WA 6923
Ph: (08) 9307 7305 Fax: (08) 9307 7309
Email: worcom@iinet.net.au

CFL & LED flicker with solid-state relays

I have a home with several home-automation solid state relays (SSRs) with low-voltage DC inputs switching 230VAC and these have been operating for several years with no issues with incandescent globes. However, whenever I try to put in CFL globes, all "flash" at about two cycles per minute which is not ideal; so I am stuck with incandescents.

Recently, I purchased several Osram and Philips LED globes and tested these. The Osram ones do not flash but the Philips ones do flash, so my question is, is there anything I can add (eg, a capacitor) to prevent this from happening either on the DC or (more likely) the AC side? I prefer the Philips globes as they give a warmer output than the Osram.

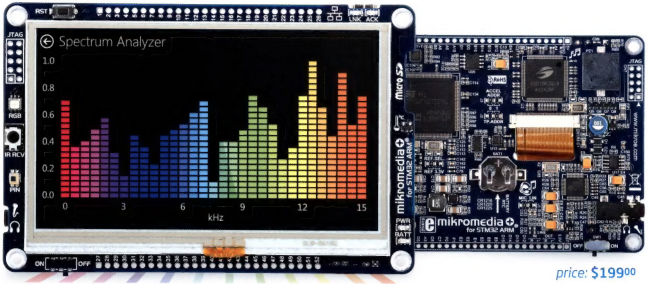
I also have 12V garden lights (LEDs) that operate via one of these SSRs and a transformer and they also flash but at a slower rate; every three seconds.

I would rather not use relays as I don't see the need in this day and age. I just thought you may have some suggestions how to overcome this. (D. H., via email).

● It is likely that the SSRs have a minimum operating current and the CFLs and LEDs may be close to that current and thereby cause them to flash. That is why incandescents with their higher current are OK. Apart from increasing the load current, nothing can be done to cure the problem. SC

Advertising Index
ADM Instrument Engineering 5
Altronics 80-83
Dimitech 21
Elcomtel 103
Embedded Logic Solutions 99
Emona Instruments 61
Front Panel Express 7
Grantronics 103
Hare & Forbes ..... OBC
High Profile Communications 103
Instant PCBs 103
Jaycar IFC,49-56
Keith Rippon 103
KitStop 10
LED Sales 103
Low Energy Developments 103
Microchip Technology 23
Mikroelektronika ..... IBC
Ocean Controls 9
Quest Electronics 103
Quick Thinking Pty Ltd 7
Radio, TV & Hobbies DVD 93
RF Modules 104
Sesame Electronics 103
Silicon Chip Binders 95,103
Silicon Chip Online Shop 96-97
Silicon Chip Subscriptions 73
Syndetic Pty Ltd 59
Tekmark Australia 6
Wiltronics 8
Worldwide Elect. Components 104

Ever Tried **168MHz**
on a microcontroller?



price: **$199**00

mikromedia+ for STM32

ARM Cortex™-M4 on-board.

Power of 168 MHz

Once you experience 168 MHz on a microcontroller, you won't be turning back. Mighty STM32F407ZGT6 with FPU has a breathtaking performance.

Size does matter.

Large 4.3" Touch Screen

It's time to see the big picture. New 4.3" touch screen driven by SSD1963 graphics controller delivers crystal sharp image in 480x272px resolution.

Communicate wirelessly.

2.4GHz RF transceiver

Nordic's nRF24L01+ transceiver with active chip antenna will make you forget about wires. Drive it with simple UART commands. It's that easy.

Yes, it has everything.

A whole lot of modules

Board has it all: USB connector, temp. sensor, RTC battery, PIN photosensor, IR receiver, accelerometer, battery charger, MP3 codec, buzzer, etc.

MikroElektronika
DEVELOPMENT TOOLS | COMPILERS | BOOKS

GET IT NOW
www.mikroe.com

ALL YOUR EQUIPMENT ESSENTIALS

Industrial Drill Sets

- Precision ground flutes
- HSS M2 bright finish
- 118° split point centre

25 Piece
- 1-13mm range

$79 (D1271)

29 Piece
- 1/16 - 1/2" range

$79 (D1281)

Metric & Imperial Drill Gauge

- Metric / Imperial
- Stainless steel
- 1-13mm
- 1/16 - 1/2"

$14 (M988)

WHG-6 Wood Working Digital Height Gauge

- 0-150mm measuring capacity
- Horizontal & vertical measuring
- Digital reading in mm, inches & fractions
- Includes CR2032 3V lithium battery

$25 (W643)

NEW RELEASE

SPD-20B Pedestal Drill

- 16-speed
- 2MT spindle taper
- 16mm drill capacity
- Safety micro switch on belt cover
- 1hp 240V motor
- Includes 16mm drill chuck & arbor

$309 (D140)

Includes **FREE** 100mm vice (V124)

Valued at $22

EDBD-13 Drill Sharpener

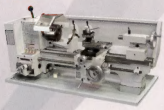
- 3-13mm - 1/8"-1/2" capacity
- Fixed drill point 118°
- Capable of split point sharpening
- Grinds two flute drills of unlimited length
- 80W 4200rpm 240V motor

$89 (D070)

AI-50GA Bench Lathe

- 230 x 500mm capacity
- 20mm spindle bore
- 0.75hp 240V motor
- Induction hardened "V" beds
- 6 spindle speeds 100-1800rpm
- Auto Longitudinal Feed
- Metric & Imperial thread cutting
- Norton style quick change gearbox

$995 (L157)



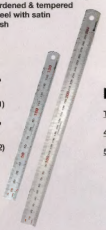
Steel Rules

- Metric one side / Imperial on the other side
- Rust & wear resistant for durability
- Made of hardened & tempered stainless steel with satin chrome finish

150mm/6" $6 (Q620)

300mm/12" $12 (Q621)

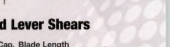
600mm/24" $18 (Q622)



70-630 Double Ended Scriber

- 190mm hardened steel
- Features straight & 90° tips with knurled body

$9 (Q630)



Cast Iron Bench Vices

- Acme screw thread

No. 4
- 100mm
- 120mm max. opening

$59 (V088)

No. 5
- 127mm
- 150mm max. opening

$89 (V089)

No. 6
- 152mm
- 195mm max. opening

$129 (V090)

Hand Lever Shears

Thick	Cap.	Blade Length	
4mm	150mm	$88	(S186)
5mm	300mm	$149	(S188)

IWB-40 Ultimate Industrial Work Bench, Backing Panel, Tooling Cabinets, Stool & Storage Accessories Package

ALL ITEMS SOLD SEPARATELY

IWB-40 Work Bench	(A420)
IBP-ST Backing Panel	(A426)
HC-2 Under Bench Cabinet	(A422)
TC-750 Tooling Cabinet	(T764)
GSP-795 Pneumatic Stool	(A359)
4 x Single Prong Hook	(A440)
4 x Double Prong Hook	(A442)
1 x Triple Prong Hook	(A444)
1 x Spanner Holder	(A446)
1 x Screw Driver Holder	(A448)
Plastic Buckets	
• 8 x (110 x 105 x 50mm)	(A430)
• 8 x (140 x 105 x 75mm)	(A432)
• 6 x (220 x 140 x 125mm)	(A434)

PACKAGE DEAL $1,395 (K035)

HL-35LT 3W LED Work Light

- 3 x LED's
- Flexible arms
- 35 watt / 240V

$129 (L2814)

HL-22FR 22W Fluorescent Work Light

- Fluorescent tube with 5X magnify
- 3 x pivot arm
- 22 watt / 120V

$139 (L282)

ORDER NOW!

USE PROMO CODE: CHIPSET TO RECEIVE THESE SPECIAL PRICES ONLINE OR INSTORE! Valid until 30-07-13

Specifications & Prices are subject to change without notification. All prices include GST and valid until 30-07-13

HARE&FORBES MACHINERYHOUSE

NSW	QLD	VIC	WA
(02) 9890 9111	(07) 3274 4222	(03) 9212 4422	(08) 9373 9999
1/2 Windsor Rd, Northmead	626 Boundary Rd, Coopers Plains	1 Fowler Rd, Dandenong	41-43 Abernethy Rd, Belmont

www.machineryhouse.com.au

7.5C.2606/13